SCINTREX

OPERATIONS MANUAL
OMNI-PLUS
VLF/MAGNETOMETER SYSTEM

geophysical and geochemical instrumentation and services

OPERATIONS MANUAL
OMNI-PLUS
VLF/MAGNETOMETER SYSTEM

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NOTE

This manual has been written for the software released after July 1988. To determine if your system has the latest software version, look under culture code 51. For VLF, the code will be U12G (VLF12G) and for resistivity, the code will be r22G (RES22G). If features or descriptions noted in this manual do not correspond with those of your system, please call EDA Instruments for further instructions. Any comments on this manual, the instrument or procedures would be greatly appreciated.

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SECTION 1

GENERAL INFORMATION

1.1 SCOPE OF MANUAL

This manual describes the OMNI-PLUS combined magnetometer/VLF system designed and manufactured by EDA Instruments Inc. EDA Instruments Inc.'s head office is located in Toronto, Ontario, Canada with offices located in Denver, Colorado, U.S.A. and distributor's worldwide. This manual was written to assist the user in the proper operation of the system and therefore, should be read prior to the testing and operation the unit. Also, the manual will provide references to the proper maintenance and understanding of all the features incorporated. The technical specifications are given in Table 1.1.

1.2 PURPOSE OF THE INSTRUMENT

The OMNI-PLUS is a portable, microprocessor-based magnetometer/VLF system which is capable of measuring changes or contrasts detected by two different types of geophysical methods: Magnetic and VLF Electromagnetic (magnetic and electric). A measurement from both these methods can be read and stored in as little as 4 seconds. The data is both sensitive and highly repeatable.

The OMNI-PLUS is a multi-purpose instrument designed to operate as: a magnetometer ; a combined magnetometer/VLF system or a VLF system. The configurations of the magnetometer system are as follows:

a. Tie-line magnetometer.

b. Total field magnetometer.

c. Recording base station magnetometer.

d. Gradiometer.

The primary purpose of the system is to:

* measure and store the magnitude of the earth's magnetic field independent of it's direction.

* measure and record the secondary field components of the primary field from up to three VLF transmitting stations.

Further details of the methods measured are given in Section 3 of this manual.

The configurations of the VLF system are as follows:

a. Tie-line VLF system.

b. VLF field system.

c. VLF base station system.

Measurements are obtained by the use of two sensors; a proton precession sensor carried on a pole to measure the magnetometer total field magnitude and; a three-component sensor worn on the back to measure the magnetic component of the VLF secondary field. In addition, probes attached through the VLF circuitry housing are used to measure the electric component of the VLF secondary field. An electronics console is worn on the front of the operator that allows the operator to view and store the collected data in internally protected memory. The data stored is protected by a lithium battery which also powers a real-time clock.

Along with the magnetometer and VLF data, the OMNI-PLUS stores the following information:

-line number
-position number
-date and time
-direction of travel
-statistical error of the magnetometer readings
-signal strength and rate of decay of the magnetometer sensor
-direction, in degrees, of the primary field in relation to the operator.
-signal strength and operator quality of the VLF sensor
-natural and cultural features

The data can be stored using three different types of storage modes:

Spot Record -which assigns a record number to the readings.

Multi Record -which assigns a line and position value to the reading using the value last stored in memory. This feature allows for multiple readings at one station.

Auto Record -which assigns a line and position value automatically incremented from the last station using the station(position) spacing entered by the operator. This allows the operator to increment or decrement the position without pressing any of the line or position keys.

The standard OMNI-PLUS has the capability of storing up to 1300 readings consisting of a total field and vertical gradient magnetometer reading , three VLF frequencies and the associated information mentioned previously.

Also, for simplicity of operation, the record keys are used to initialize the system and to retrieve the data stored in memory. Any of the three memory keys may be used for these functions.

The OMNI-PLUS, as with the OMNI IV, stores only the raw data for both the VLF and magnetometer measurements. Corrections for magnetometer diurnal variations and VLF primary field variations on each of the total field measurements are performed internally using either the tie-line (looping) method or a compatible base station unit. For correcting the magnetometer total field values, a PPM-375, PPM-400, OMNI IV or OMNI-PLUS system may be used. However, for correcting the VLF total field, only a OMNI-PLUS can be used.

Further, the raw data is retained until the instrument is re-initialized even after corrected data has been computed.

Data stored in memory is completely protected by a lithium battery. This battery also powers the real time clock.

Field Measurement Features

The OMNI-PLUS has been designed to provide the user with features that will enhance both the ease of use and data quality. These features are noted below in their magnetometer and VLF components.

The OMNI-PLUS has been designed to simultaneously measure the VLF and magnetometer components. When the READ key is pressed the previous magnetometer or VLF reading is displayed followed by the new corresponding reading for your particular station. At this point, all measurements have been completed and the data may be stored using one of the RECORD keys. If the operator tries to store the data prior to completion of the VLF measurements, the word "wait" will appear on the display indicating that the VLF measurement process is not completed. Once the VLF measurements are completed, the data may be stored.

The instrument outputs the data as it is recorded (ie. The direction the operator is walking). The station and line values are stored using +/- designations. However, the data may be later outputted using N,S,E or W signs (see Section 6).

Natural/Cultural Features. The OMNI-PLUS is equipped with a "built-in notebook" with actual words of features that the operator may wish to record along with the data. The features are accessed using the SPECIAL key and is described on page 4-21 of this manual.

VLF Features

Systematically Monitor Three Stations. The OMNI-PLUS monitors the VLF frequencies selected for operator quality and signal/noise during each reading. The results are both displayed as descriptor bars and stored in internal memory along with the field results.

Operator quality is a value to help the operator determine whether the measurement was properly taken. Since the in-phase and tilt measurements are dependent on the sensor being within 10 degrees of vertical and motionless, the OMNI-PLUS monitors the ability of the operator to remain motionless and vertical. As mentioned, the results are outputted on the display using the DECAY descriptor bars. The increased quality of the measurement is indicated by the increased number of bars displayed to a maximum of four. Also, for each measurement, a numeric value is given which ranges from 1 to 9, where 1 is the poorest and 9 is the best. Generally, a value of 5 to 6 should be obtained to ensure an accurate reading.

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The signal/noise ratio is an actual measurement of the signal strength to the background noise. The results are outputted visually using the SENSOR descriptor bars when the VLF results are displayed. An increased signal strength is indicated by an increase in the number of bars displayed to a maximum of four. As with the operator quality, a numeric value is given which ranges from 1 to 9, where 1 is the weakest and 9 is the strongest.

Therefore, after the instrument defaults to the new measurement, the worst operator quality and the weakest signal/noise ratio is displayed for up to three VLF frequencies selected. However, if the operator wishes to see what the operator quality and signal/noise ratio is for a particular frequency, when the FREQ. SELECT key is pressed and the particular station is displayed, the operator quality and signal/noise ratio is given for that station.

Automatic Sampling Time. The OMNI-PLUS has been designed whereby, if a weak station is selected, the instrument will automatically increase the measurement period to produce higher quality results. The measurement period for one frequency may range from one to ten seconds.

Spectrum. All OMNI-PLUS systems have the spectrum feature where the operator has the ability to quickly monitor the VLF frequency range (15 to 30 kHz) to determine what stations are "on the air". When a frequency of 14.0 is selected and the instrument is programmed for base station mode, the OMNI-PLUS will automatically take a measurement every 100 Hz starting at 15.0 kHz. This data can then be outputted, where a viable signal will be indicated by a symetrical "bell-shaped" peak.

NOTE

The spectrum can be run in the VLF mode whereby each time the READ key is pressed, the instrument will automatically increment by 100 Hz.

Corrected VLF Total Field Results. The VLF total field data can be corrected for primary field variations. This can be achieved using either the tie-line method or more accurately, a base station unit. However, since the OMNI-PLUS requires no orientation for the VLF, one magnetometer total field and up to three VLF frequencies can be measured with one system. The VLF total field is corrected as a ratio, thereby, the corrected results are normalized.

Readings Adjusted for Sign Convention. In standard VLF survey methods, a single or consistant direction is used to maintain comparable signs on all in-phase, quadrature or tilt values relative to each other. Since the OMNI-PLUS is a no orientation system, a convention was selected that maintained the standard convention that North and East are positive and South and West are negative.

Therefore, the profiles plotted looking east (i.e. S to N) and north (i.e. W to E) will have the crossover in the correct sense (positive to negative).

Error Messages. To assist the operator in determining whether there are any external or internal problems affecting the performance of the system, error codes have been implemented to indicate to the operator where the problem exists.

Automatic Calculation of Fraser Filter. The OMNI-PLUS automatically calculates the Fraser Filter, from the tilt data, regardless of the interval between the stations along the grid lines. The Fraser Filter algorithm follows established conventions.

Change Frequencies During The Survey. If during the survey day the operator notices that one of the frequencies has "gone off the air", he can change one or all of the frequencies without losing the previously stored data.

To change the frequencies, the operator places the instrument in TEST mode and presses one of the RECORD keys. At this point, the first frequency will be displayed and the operator may change this or any of the others as per our instructions (Section 5).

NOTE

For users of the GEOSOFT Mapping System, the OMNI conversion program will not recognize any frequency changes from those used at the start of the data set.

FOR A SUMMARY OF THE VLF FEATURES, SEE SECTION 9 OF THIS MANUAL FOR FURTHER DETAILS.

Magnetometer Features

Polarizing Cycle. During this period the sensor or sensors are energized. The OMNI-PLUS as with the OMNI IV magnetometers utilize the principle of constant energy polarization. Most instruments utilize a fixed polarization time regardless of the battery voltage. It can be demonstrated that with such a method, a 40% deterioration occurs in sensor signal strength rendering the instrument to be more and more inaccurate (scatter phenomena).

The microprocessor within the instrument computes the battery voltage during polarization and at a specific point determines whether or not the polarization time should be increased. This method ensures that the sensor always receives the same amount of energy per unit of time. Although the performance is not linear, a significant improvement results even when the battery is approaching the depletion state.

Signal Analysis Cycle. At the end of the sensor energizing period, the signal decay cycle occurs. The precession signal is monitored and the decay rate analyzed. This precession signal is compared statistically to an optimized decay curve at 400 points along the curve. Computations are made and result of the computations displayed as error.

Tuning Sequency. After the signal analysis period, this new value becomes the basis for the next reading. The measurement portion of the reading sequence occupies typically 2 seconds.

Display Cycle. The selected parameter is displayed on the liquid crystal display (LCD) for approximately 29 seconds. At this time, the audio circuits provide a sequence of beeps which indicate that the instrument will be shut down after another 30 seconds unless the same command or another command is keyed.

Note

During this cycle, valid readings, location and time values are entered into scratch-pad memory as a data block.

To summarize, a typical reading sequence terminates after about 59 seconds. Then the computer turns off the power.

Audio Circuits. The instrument provides both visual and audio feedback. Every time that a key is pressed, an audio beep will be heard. Parameters are displayed for 29 seconds only. The moment that this visual period has elapsed, the audio is activated to give repeated beeps for another 30 seconds period to indicate the end of the data block display period. If the operator fails to press any key during this warning period, the instrument turns off automatically. Every time that a key is pressed, a new 29 second period is initiated. This allows the operator to have time to evaluate the program data. This display period may be extended by pressing the same key or another key. However, selection of a different key initiates a different display response.

Statistical Error Alarm. Following each reading, the instrument computes the true statistical error of total field reading. This value represents the confidence level of data. A visual alarm may be triggered based on the following criteria:

a. When a statistical error of a particular reading is equal to or larger than 0.2 gamma, the least significant digit of the displayed total field flashes on and off. For example, assume that this statistical error is 0.23 gamma and the displayed total field is: 57936.4. In this case, the 4 flashes on and off. Flashing the least significant digit on and off indicates that the accuracy is impaired and the operator should be warned.

b. When the statistical error of a particular reading is equal to or larger than 2.0 gammas, the last two least significant digits of the displayed total field flash on and off. For example, assume that the statistical error is 2.3 gamma and the displayed total field is: 57936.4. In this case, the 6 and 4 flash on and off. Flashing the two least significant digits on and off indicates that the accuracy is badly impaired and an audio warning sounds to alert the operator.

Note

If the error is larger than 2.0 gammas, take another reading.

Automatic Fine Tracking (Tuning) of Magnetometer Total Field
The OMNI-PLUS contains high technology circuits which allow for automatic fine tracking (tuning) over the entire field strength from 18,000 to 110,000 gammas, under computer control. An optimized tuning algorithm ensures that the system is tuned for optimum performance.

Under normal operating conditions a ±15% capture tuning range from reading to reading is achieved. The capture tuning range is defined as the difference between the previous and current readings relative to the previous reading. However, if a larger difference is computed, the instrument will warn the operator of this and further measurements are inhibited automatically. The warning is both visual and audible. The displayed total field reading is flashed on and off along with an audio alarm to inform the operator that the displayed value is invalid. The value displayed, however, is the previous total field value, and should be changed manually to reflect the new tuning field.

1.3 FUNCTIONAL DESCRIPTION

The OMNI-PLUS Magnetometer/VLF System is a ruggedized, compact, portable instrument designed specifically for field operation. It allows for quick surveying capability without sacrificing accuracy and quality data. It contains several microprocessors and associated circuitry for monitoring, processing and storing data. As with the OMNI IV, the OMNI-PLUS has two memories: for the tie-line points and the field measurements of the survey.

Physical Dimensions	Wt(kg):	w x h x d(mm)
Instrument console only	3.8:	122 x 246 x 210
Battery cartridge	1.8:	540 x 100 x 40
Battery belt	1.8:	138 x 95 x 75

Sensors

Magnetometer remote sensor	1.2:	56 dia x 220
Magnetometer gradient sensor	2.1:	56 dia x 790
VLF sensor module	2.6:	280 x 190 x 60

Environment

Electronics
- Operating temperature range... -40 C to +55 C
- Relative humidity..... 0 to 100% (weather-proof)

Magnetometer Sensors
- Temperature range..... -45 C to +55 C
- Relative humidity..... 0 to 100% (weather-proof)

VLF Sensor
- Temperature range..... -45 C to +55 C
- Relative humidity..... 0 to 100% (weather-proof)

Standard Memory Capacity

Field unit	1300 sets of readings
Tie-line points	100 sets of readings
Base staion	5500 sets of readings

Electronics

RS-232C serial I/O..... 300 to 9600 baud(programmable); 8 data bits, 2 stop bits; no parity

Electronics console..... Enclosure contains electronics and battery pack (if not contained in separate belt). Front panel includes liquid crystal display (LCD), and keypad.

Power Supply..... Internal battery pack or external battery belt; or 12V car battery (base station).

Table 1-1 Technical Summary

SECTION 2

PHYSICAL DESCRIPTION

2.1 SYSTEM COMPLIMENT

As with the OMNI IV, the OMNI-PLUS can be configured in three ways depending on the magnetometer requirements. As previously mentioned, these are:

Total field, tie-line or looping application.
Base station application.
Vertical gradient application.

For each of these applications, VLF measurements will be automatically performed if a VLF sensor is connected.

Table 2-1 lists the standard and optional components of the OMNI-PLUS in each of it's three configurations.

Item	Total Field	Base Station	Gradiometer
OMNI-PLUS VLF/Magnetometer Console			
128K RAM Memory	Standard	Standard	Standard
Display Heater	Standard	Standard	Standard
Magnetometer Components			
Remote Sensor	Standard	Standard	N/A
0.5m Gradient Sensor	N/A	N/A	Standard
1.0m Gradient Sensor	N/A	N/A	Optional
Pole Assembly (4-600mm sections)	Standard	Standard	Standard
30m Cable Extension	N/A	Optional	N/A
Rope Joiner	N/A	Standard	Standard
VLF Components			
VLF Sensor Module	Standard	Standard	Standard
VLF Interconnect Cable	Standard	Standard	Standard

Table 2-1 OMNI-PLUS System Compliments

Item	Total Field	Base Station	Gradiometer
Power Sources			
Battery Cartridge (rechargeable)	Standard	Standard	Standard
Battery Belt (rechargeable)	Optional	Optional	Optional
Battery Belt (alkaline)	Optional	Optional	Not Recommended
Battery Charger 110/220 Vac	Standard	Standard	Standard
Operation Manual	Standard	Standard	Standard
VLF Resistivity	Optional	Optional	Optional
Magnetometer Memory Upgrade	Optional	Optional	Optional
RS232C Serial Interface Cable	Optional	Optional	Optional
Transit Case	Optional	Optional	Optional

Table 2-1 OMNI-PLUS System Compliments (con't)

2.2 COMPONENT DESCRIPTION

INSTRUMENT CONSOLE The primary electronics, data acquisition circuit, microprocessor and memories are built into a rectangular, aluminum, weather-proof case with the instrument panel facing upwards. This console is supported in a dual shoulder-type harness and is carried on the chest.

Display Operator modes, data and information is displayed on a custom-designed, ruggedized liquid crystal display (LCD) which operates in temperatures ranging from -40 C to +55 C. The display includes a six-numeric digit readout, decimal point, mode function readout, battery status monitor, signal decay rate, signal amplitude monitor, VLF signal strength and operator quality monitors and parameter indicators. The internal heater is activated automatically at -25 C during the survey. The mode selector should be set to OFF overnight and when the unit is not being used to avoid power comsumption from the heater at low temperatures.

Operator Keys The operator keys are grouped into two sections located on each side and below the LCD. The 12 keys on the left hand side are for programming the instrument. The 10 keys on the right hand side are for taking measurements and recording them, accessing the VLF magnetic and electric parameters and accessing the electronics notebook. The one key below the LCD is the mode selector, where the modes are viewed on the LCD. The key functions are described in Section 4.

Cable Connectors There are two cable connectors located on the rear of the instrument. When the console is being used (ie,chest mounted):

* The one on the operator's left side connects the magnetometer sensor. The type of connector is the same as those used for the PPM and OMNI IV series of magnetometers. Therefore, magnetometer sensors are interchangeable between systems.

* The one on the operator's right side is for interconnecting the console with the VLF sensor and for dumping the stored data. (Note: If the interconnect cable becomes unusuable, the data transfer cable may be used where the base station connector is attached to the console and the field connector is attached to the VLF sensor).

SENSORS The OMNI-PLUS system consists of two types of sensors; the magnetometer proton precession sensor and the VLF three-component sensor.

Magnetometer Sensor The sensor consists of two helical coils of copper wire connected in series in a noise-cancelling mode with a least 50 dB attenuation of external noise. The coils are immersed in a hydrocarbon-rich liquid inside a lightweight, leakproof cylinder. The sensor cylinder is mounted inside a thin-wall fiberglas tube. the coils are positioned with their axes parallel to each other. The interconnections are carried through a cable, 3m long and terminated in a connector which interfaces with a connector on the rear of the OMNI-PLUS. This configuration is for a remote sensor to be used when the the system is being operated as a field, tie-line, looping or base station unit.

Dual Gradient Magnetometer Sensor For the gradiometer application, two identical sensors are mounted vertically at the ends of a rigid fiberglas tube. In the standard configuration, the centers of the coils are spaced 0.5m apart. An optional configuration separates the coils by 1.0m. It should be noted that through a patented measuring process, the two coils are read simultaneously, thereby aleviating the need to correct the gradient readings for diurnal variations. The interconnections are the same as those for the remote magnetometer sensor. It should be noted that a gradient sensor may be used when the magnetometer portion of the OMNI-PLUS is configured as a field, tie-line, looping or base station unit.

Sensor Poles The pole consists of four 600mm sections which engage end to end so that the remote magnetometer sensor is approximately 2.5m above the ground. For base station applications, a rope joiner is supplied and is attached between the top section of pole and the magnetometer sensor. Rope is the attached to the four holes and is secured in the same fashion as a tent guy rope.

VLF Sensor Module The VLF sensor module consists of three sections: the VLF sensor; the circuitry; the back-pack frame.

The VLF sensor consists of three orthogonal coils mounted in a cylindrical housing with a pre-amp signal circuitry. The coils consist of copper wire wound on a non-ferrous frame. These coils are mounted with two coils horizontal and one mounted vertically. The sensor housing is made of a ruggedized plastic material.

The VLF circuitry is housed in a ruggedized, rectangular, metal or plastic housing and consists of three circuit boards.

The circuit boards contain a microprocessor, CPU circuitry, a tilt correction meter and signal filtering circuitry. For the standard OMNI-PLUS configuration, the circuitry housing has one KPT type connector which allows for interfacing with the OMNI-PLUS console. For the optional VLF resistivity, additional KPT type connectors are installed for connecting the resistivity probes.

Both the VLF sensor and circuitry housings are attached to a rigid polethelyne frame. To the back of the frame is permanently attached a neoprene foam padding that allows for comforable field usuage. The foam is closed-celled a will not absorb water or perspiration.

Power Supplies Three types of power supplies are available for use with the OMNI-PLUS with a) the standard:

a) A non-magnetic rechargeable battery cartridge with eight lead acid cells.

b) A non-magnetic rechargeable battery belt with eight sealed lead acid cells.

c) An alkaline battery belt with 12 "D" size alkaline disposable power cells (not recommended for use with the gradiometer).

A) **Rechargeable Battery Cartridge** The cartridge consists of eight lead acid cells securly fashioned in a aluminum housing. The cartridge is attached to the back of the console using the four plastic clips. The cartridge can only be attached one way which is determined by the cut-out on the console backplate and the corresponding key on the cartridge. Also, the battery connector on the back of the console has two straight pins of different diameters that allow the cartridge to be attached only one way.

B) **Rechargeable Battery Belt** This is a webbed belt with a zip enclosure pouch designed specifically for rugged field use. The 8 lead acid cells are placed in protective packing inside the pouch. Powering of the console and recharging of the belt are performed through the coiled cable with a pin socket connector at the end. For powering the console, the connector is attached to the corresponding male connector on the back of the console. The two straight pins are designed so that the connector can be only attached one way. The two thumb screws allow for securing the connector to the console. At each end of the coiled cable, strain reliefs have been attached to provide extra protection

against cable breakage. For recharging the belt, the female connector of the battery belt is attached to the male connector of the battery charger and is left on until the red indicator light on the charger shuts off.

NOTE: At this time, the recharegeable battery belt is NOT to be used when VLF feature is being used. However, the belt may be used when the system is being as a magnetometer ONLY.

C) **Alkaline Battery Belt** Disposable alkaline batteries may be used to power the OMNI-PLUS system. However, the disadvantage of this method is that the batteries are depleted quite rapidly and therefore, they are not recommended for use with the gradiometer.

NOTE

The characteristics of alkaline batteries require a program variation. For this reason, the second digit of the operator code is entered as a '9' (eg, OP39NN) for alkaline batteries and any other digit for rechargeable batteries.

Base Station Power Supply Although the battery cartridge or belt supplied may be used to power the system, a 12V car battery may be used if so desired. This feature is useful especially in winter conditions, where a battery cartridge or belt may not last the full day. To use a car battery, disconnect the battery cartridge or belt and attach the data reduction cable using the connector where a red and black cable extends from it. Attach the red cable to the positive pole of the 12V battery and the black cable to the negative pole of the 12V car battery. It would be advisable to protect the rear of the console from adverse weather conditions.

NOTE

With a car battery, you will only see one bar on the battery indicator.

HARNESS A multi-functional harness is supplied with every OMNI-PLUS system. This harness may be used with or without the VLF module or magnetometer sensor. It has been designed to be durable, yet comfortable. The harness assembly comes with wide shoulder pads and tri-glides that allow the operator to customly adjust the straps to suit his or hers requirements. Setup for the harness is graphically shown on page 5-4 of this manual.

BATTERY CHARGER The battery charger supplied with the OMNI-PLUS system is designed to operate on either 120/240 volts. Generally, the user should charge the battery overnight or until the red light on the side of the unit goes out. The system has been designed with an overvoltage protection so as not to damage the batteries from overcharging. Appendix A-2 gives a detailed description on battery care and life expectancy.

SECTION 3

PRINCIPLES OF OPERATION

3.1 INTRODUCTION

This section is confined to the principles of operation of the OMNI-PLUS instrument. An explanation of the design concept and the derivation of constants used in the design concept are beyond the scope of this manual.

3.2 PRINCIPLES

The OMNI-PLUS instrument was designed to allow the user to measure and store both magnetic and electromagnetic (VLF) data separately or together with one system.

The OMNI-PLUS has the capability to measure and record the following geophysical parameters:

* The total magnetic field strength (gammas).
* The simultaneous gradient of the total magnetic field (gammas/meter).
* The VLF magnetic field of up to three VLF transmitting stations, which is outputted under the following components:
  - -the vertical in-phase (percent).
  - -the vertical quadrature (percent).
  - -the total field strength (units).
  - -the vertical dip angle (degrees).
  - -the magnetic primary field direction (degrees)
* The VLF electric field of up to three VLF transmitting stations, which is outputted by the following components:
  - -the apparent resistivity (ohm-m)
  - -the phase angle (degrees)

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* The simultaneous gradient of the total magnetic field (gammas/meter).
* The VLF magnetic field of up to three VLF transmitting stations, which is outputted under the following components:
  - -the vertical in-phase (percent).
  - -the vertical quadrature (percent).
  - -the total field strength (units).
  - -the vertical dip angle (degrees).
  - -the magnetic primary field direction (degrees)
* The VLF electric field of up to three VLF transmitting stations, which is outputted by the following components:
  - -the apparent resistivity (ohm-m)
  - -the phase angle (degrees)

Along with the above parameters, the OMNI-PLUS:

* Stores the signal strength and rate of decay for the magnetometer portion.

* Monitors the quality of up to three VLF transmitter signals being measured both through visual descriptors and a printout.

* Records location data so that each measurement can be identified in terms of geographical coordinates (or by record number) related to a precise ground location.

* Records the date and time at which reading was taken.

* Calculates and outputs a four and five point Fraser Filter of the dip angle data.

* Allows the capability to record natural and cultural features unique to each grid location.

* Records the type of data recorded, whether it is corrected or uncorrected data, operator identification number, number of readings taken, and voltages of the main and lithium batteries.

* Provides visual readouts of parameters based on keypad commands.

* Produces data block header information which identifies both the operator and instrument used.

* Produces two types of data output of the magnetometer and VLF data for printer or computer output.

* Performs built-in test programs which provide a high confidence level in field measurements.

3.3 SURVEY PROCEDURES

The procedure given here is given as a guide and may not be suited to your requirements.

The operator generally selects a station which gives the field lines approximately at right angles to the main strike of the geological structure of the area you are in (ie, the strike should point to the transmitter). Therefore, the survey lines should be selected approximately along the lines of the primary magnetic field.

Generally, in the past, only one VLF station was measured due mainly to survey costs. However, with the speed of the OMNI-PLUS and areas being examined consisting of complex structures, additional VLF information at different angles would be extremely beneficial.

How To Take A Magnetometer Reading

This section gives a simple explanation on how to take a proper magnetometer reading.

1) Assemble the console, battery, sensor and harness as explained in Section 5 of this manual.

2) Hold the pole and sensor at arms length from yourself and the console with the North (N) marking on the sensor pointing in the north direction (extremely important in equatorial regions). When the operator changes direction 180 degrees, ensure that the (N) marking on the sensor is facing north.

3) Remove all metallic objects from your person.

4) Press **MODE** **SPACING 9** Until **TEST** is flashing.

5) Press **R E A D** **56369.7** will be displayed

6) Press **A U T O** **OPNNNN** will be displayed where "N" is a numeric value.

RECORD

How To Take A Magnetometer Reading (con't)

NOTE

If OPNNNN is not displayed, follow procedures outlined on pages 6-9 and 6-10 of this manual. Turn the instrument off and repeat steps 1 through 10.

7)	Press	**CHANGE + 3000 + ENTER**	
8)	Press	**OFF**	
9)	Press	**MODE SPACING 9**	Until **TPM** is flashing
10)	Press	**R E A D**	A total field value expressed in gammas will be displayed.

NOTE 1

If the value is not that of the expected local field or the complete value on the display is flashing, then press the **FIELD/GRAD/3 + CHANGE +** a numeric value of the expected local field + **ENTER**. Turn the instrument off and repeat step 10.

NOTE 2

For a good reading, the operator should see four bars for both the DECAY and SENSOR displays. If four bars are not indicated, see Section 4 for explanations of the DECAY and SENSOR descriptors.

Calculation For Corrected Magnetometer Total Field Reading

Although the OMNI-PLUS stores all the data in an uncorrected format, the operator has the ability to present the data in a corrected format. The following formula is given to advise the operator how the corrected total field value is derived:

Corrected Total Field =
[(Uncorrected Total Field-Datum) - (Base Station Value-Reference Field)]

The Datum Value is entered in the field unit, while the Reference Field Value is entered in the base station unit (field unit if the Tie-Line Method is used). The reference field remains the same for the whole survey for it allows data from different days to be correlated. The datum value is used to remove a consistant value from the total field values thereby allowing the operator to view only the significant gamma changes pertaining to the feature being examined. Further details are given in Section 4 of this manual.

NOTE

The total field data presented in the ASCII Fixed Format Dump is in an uncorrected format. All pertinent information is given so that the corrected total field data can be calculated through a computer.

Geographic Sensing

Although the data (ie, line and station values) can be presented in a North-South or East-West format, the data can only be stored as a positive or negative value. Therefore, the following has to be observed:

1) South or west lines or stations - enter negative.
2) North or east lines or stations - enter positive.
3) Walking south or west (ie, position spacing) - enter negative.
4) Walking north or east (ie, position spacing) - enter positive (no sign).

NOTE

The sign of the position spacing is used for the line direction convention for the VLF in-phase quadrature and tilt data. See Section 9 for further details.

How To Take A VLF Reading

This section gives a simple explanation on how to take a proper VLF reading.

1) Assemble the console, battery, sensor module and harness as explained in Section 5 of this manual (Note: The magnetometer sensor does not have to connected to take a VLF reading).

2) Face the direction you will be performing the survey (ie, line direction).

3)	Press	**MODE**	**SPACING** 9	Until the mode **TEST** is flashing.
4)	Press	**R** **E** **A** **D**		The test number 56369.7 will be displayed along with the battery strength indicator and GAMMA descriptor.

How To Take A VLF Reading (con't)

5) Press **A U T O** — OPNNNN will be displayed where "N" is a numeric value.

RECORD

NOTE

If OPNNNN is not displayed, follow procedures outlined on pages 6-9 and 6-10 of this manual. Turn the instrument off and repeat step 5.

6) Press **CHANGE + 30000 + ENTER**

7) Press **A U T O** — 1F NN.N will be displayed where "N" is a numeric value.

RECORD

8) Press **CHANGE + 240 + ENTER** (Or any other frequency aplicable to your area)

For Resistivity Option Only:

9) Press **A U T O** — 1rSPNN.N will be displayed, where "N" is a numeric value.

RECORD

10) Press **CHANGE + 000 + ENTER**

---

11) Press **A U T O** — 2F NN.N will be displayed, where "N" is a numeric value.

RECORD

12) Press **CHANGE + 000 + ENTER**

How To Take A VLF Reading (con't)

13) Press **A U T O** **RECORD** — **3F NN.N** will be displayed, where "N" is a numeric value.

14) Press **CHANGE** + **000** + **ENTER**

15) Press **A U T O** **RECORD** — **P NNNN** will be displayed where "N" is a numeric value.

16) Press **CHANGE**

17) Press **ENTER**

18) Stand straight as possible.

19) Stand as still as possible.

20) Press **A U T O** **RECORD** — **init** will be displayed. The system is calibrating the VLF. After this process is over (approximately 10 to 30 seconds), a **1 NNNN** will be displayed where **N** is a calibrated field number. The values from the initialization process are very important and are explained on pages 5-31 of this manual.

21) Press **TIEBASE** (twice) **-** **SPOT** **RECORD** — The values are now stored and the instrument shuts off automatically.

22) Press **MODE** **SPACING** — Until **VLF** is flashing.

How To Take A VLF Reading (con't)

23)	Press	R E A D	WAit will appear on the display while the signal is being processed. When the processing is completed 1 NNNN will appear where the 1 is the frequency number (ie, 1st frequency selected) and NNNN is the measured VLF total field intensity. By pressing the VLF key, the operator can scroll through the other measured parameters. The manual explains in detail the values and their purpose.

NOTE

When the VLF total field intensity is displayed (or any of the other parameters under the VLF key), there are three sets of descriptor bars. Each of these sets of bars is an important tool in advising the operator of the status of the system. **PLEASE READ THE MANUAL SO YOU ARE AWARE OF THESE DESCRIPTORS BEFORE PROCEEDING ON AN ACTUAL SURVEY.**

SECTION 4

OPERATION

4.1 ARRANGEMENT

The electronic console includes:

a. An operating-mode key with thirteen positions viewable on the LCD display.

b. A programming keypad on the left side, with 12 pressure sensitive keys.

c. A recording-programming keypad on the right side, with 10 pressure sensitive keys.

d. An LCD multi-function display with digital readout.

These are all necessary for programming and operating the instrument and storing field measurements.

4.2 DESCRIPTION OF SWITCHES AND INDICATORS

The locations of the MODE selector positions, the programming and recording keypad push-buttons, are shown in Figures 4-2, 4-3 and 4-4 respectively. Their functions during normal operation are given in Tables 4-1, 4-2 and 4-3 respectively. The liquid crystal display(LCD) is shown in Figure 4-5. The descriptions are explained in Table 4-4.

4.3 MODE KEY

At the lower edge of the electronics console is a pressure sensitive key which activates the LCD display to indicate the 11 modes available. These selections permit field measurements, data retrieval, functional testing and battery power conservation.

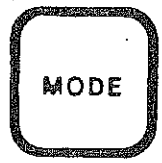

Figure 4-1 Mode Selector

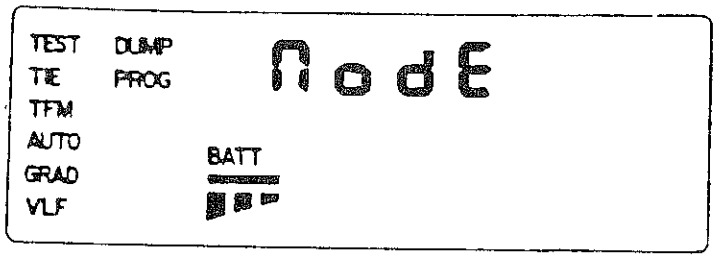

Figure 4-2 Mode Selections Viewed On Display

Description	Function
MODE key	This pressure sensitive key allows the operator to activate, view and select different operating modes.
OFF	The display heater circuit is disabled when the MODE key is set to OFF. This prevents unnecessary battery power drain when the ambient temperature drops below -25'C and the instrument is not being used.

NOTE

The display heater circuit becomes activated automatically when the temperature is below -25'C and the MODE key is not set to OFF.

Table 4-1
Mode Selections Viewed On Display

Description	Function
TEST	In this mode, the unit may be tested by pressing the READ key. For the magnetometer portion of the instrument, a synthetic test is conducted to verify proper operations of the electronics and program software. The test result, which is a total test field expressed in gammas, appears on the display, (ie, **56369.7 gamma**). The program memory is also subjected to a test. In addition, when the ERROR key is pressed, prope operation of the mathematical statistical error routine is verified, (ie, LCD displays .00 GAMMA For the VLF portion of the system, the calibrati of the coils and system check is performed durin the initialization process (see Section 5). The results are subsequently used in the actual VLF readings. **NOTE** **Generally, all the programming (ie, line position, time implementation) is performed in this mode.**
TIE	In this mode, tie-line or looping data is taken and recorded in a separate memory. This becomes the baseline data which is recalled automaticall and used by the microprocessor to correct survey readings taken later during the course of the survey. The TIE memory data is used to automatically correct magnetic diurnal variations of the total field reading and primary field variations of th VLF total field readings.

Table 4-1
Mode Selections Viewed On Display

Description	Function

TIE

For TIE, each data block stored in the separate memory contains:

a. Time of reading (HH:MM:SS).
b. Magnetometer total field intensity.
c. Magnetometer statistical error analysis.
d. Grid coordinates (line number, position number).
e. Magnetometer decay rate.
f. Magnetometer signal strength.
g. VLF frequency.
h. VLF vertical in-phase.
i. VLF vertical quadrature.
j. VLF vertical dip angle.
k. VLF primary field intensities.
l. Direction of the primary field in relation to the operator.
m. Cultural features (if recorded).
n. Operator quality.
o. Signal/noise ratio.

NOTE

Tie-line data can be recalled even if stored on different days.

Table 4-1
Mode Selections Viewed On Display

Description	Function
TFM (Total Field Mode)	This is the selection for normal operation during a survey. In this mode, the instrument may be operated normally to measure and store the magnetometer total field intensity along with the selected VLF frequencies. For TFM, each data block stored in memory contains: a. Time of reading (HH:MM:SS). b. Magnetometer total field intensity. c. Magnetometer statistical error analysis. d. Grid coordinates (line number, position number). e. Magnetometer decay rate. f. Magnetometer signal strength. g. VLF frequency. h. VLF vertical in-phase. i. VLF vertical quadrature. j. VLF vertical dip angle. k. VLF total field intensity. l. Direction of the primary field in relation to the operator. m. Signal/noise ratio. n. VLF quality control value. o. Cultural feature (if recorded). **NOTE** The VLF parameters will be recorded if a VLF sensor is used and the instrument has been programmed to measure VLF frequencies.
AUTO	This is the base station mode. In this mode, data is taken and accumulated in memory to monitor the earth's magnetic field and VLF primary field variations at the base station location. Readings are taken at the preprogrammed time interval. This time interval can be varied from 5 seconds to 60 minutes in one second increments. At present, 5580 data blocks can be stored in memory. Each data block contains:

Table 4-1
Mode Selections Viewed On Display

Description	Function
AUTO	Magnetometer: a. Time of reading (HH:MM:SS). b. Magnetometer total field intensity. c. Difference from the programmed magnetometer base reference field value. d. Difference from the previous reading (ie. drift). VLF: a. Time of reading (HH:MM:SS). b. VLF frequency. c. VLF total field intensity. d. VLF vertical in-phase.
GRAD	This is the gradiometer mode. In this position, two measurements are made: a. The magnetic total field intensity is measured using the top sensor. b. The gradient of the magnetic total field is calculated by taking simultaneous readings with both sensors separated by a distance of 0.5m or 1.0m.

Table 4-1
Mode Selections Viewed On Display

Description	Function
GRAD	For GRAD, each data block stored in the magnetic section of the memory contains: a. Time of reading (HH:MM:SS) b. Magnetic total field intensity (top sensor). c. Gradient measurement. d. Statistical error analysis. e. Grid coordinates (line number, position number). f. Decay rate. g. Signal strength. **NOTE** If the VLF module is connected and applicable VLF stations have been programmed, the VLF parameters will be read automatically.
VLF	This mode is used when the operator wants to use the instrument to measure VLF only. In this mode, each data block contains: a. Time of reading (HH:MM:SS). b. Grid coordinates (line number, position number). c. VLF frequency. d. VLF vertical in-phase. e. VLF vertical quadrature. f. VLF total field intensity. g. VLF vertical dip angle. h. Direction of the magnetic primary field in relation to the operator. i. VLF signal strength. j. VLF quality control value. k. Cultural feature (if recorded). l. Apparent resistivity (with resistivity option) m. Phase angle (with resistivity option)

Table 4-1
Mode Selections Viewed On Display

Description	Function
VLF TIE	In this mode, tie-line or looping data of the VLF total field is taken and recorded in a separate memory. This becomes the baseline data which is recalled automatically and used by the microprocessor to correct survey readings taken later during the course of the survey. The VLF TIE memory data is used to automatically correct VLF primary field variations of the total field reading. This mode is used when no magnetometer data is to be collected. For VLF TIE, each data block stored in the separate memory contains: a. VLF frequency. b. VLF vertical inphase. c. VLF vertical quadrature. d. VLF vertical dip angle. e. VLF total field intensity. f. Time of reading (HH:MM:SS). g. Grid coordinates (line number, position number). h. Direction of the primary field in relation to the operator. i. Signal/noise ratio j. Operator quality. k. Cultural features (if recorded).
VLF AUTO	This is the VLF base station mode. In this mode, data is taken and accumulated in memory to monitor the primary field variations of the VLF frequencies used at the base station location. Readings are taken at the preprogrammed time interval. This time interval can be varied from 5 seconds to 60 minutes in one second increments. At present, 5580 data blocks can be stored in memory. Each data block contains: a. Time of reading (HH:MM:SS). b. VLF frequency c. VLF total field intensity. d. VLF vertical in-phase.

NOTE

When programming the time interval, the time selected should be a minimum of two seconds greater than the combined time required to measure each frequency separately.

Table 4-1

Mode Selection Viewed On Display

Description	Function
DUMP	This mode is used to access the stored magnetometer data through a RS232C serial port to an external, compatible printer or computer. The data is retrieved from the protected memory using various access codes. In this mode, the baud rate may be programmed from 300 to 9600 baud depending on the computer's or peripheral's requirement.
PROG	This position is applicable to all the magnetometer modes. In this mode, data can be outputed in an analog profile plot format. Scaling of the profile plot is programmed through the keypads. This selection also outputs the magnetometer data in a fixed ASCII format for further computer processing.
VLF	This position is applicable to the VLF portion of **DUMP** the data. In this mode, the data is retreived from the protected memory using various access codes. In this mode, the baud rate may be programmed from 300 to 9600 baud depending on the computer's or peripheral's requirement.
VLF PROG	This position is applicable to the VLF data only. In this mode, VLF data is outputted in a fixed ASCII format for further computer processing. No analouge profile plot format has been implemented at this time.

NOTE

The magnetometer data outputted with the VLF data should NOT be used. This line of data is given to provide time, line and position information ONLY.

Table 4-1
Mode Selections Viewed On Display

4.4 KEYPADS

The console is equipped with a ruggedized, waterproof, "Repex" resistant keypad. This keypad is divided into two sections: One for the programming the instrument; the other for recording and modifying measurement and reference data. The keys are of the touch sensitive type, however, to activate a key some pressure must be applied. An audio tactile feedback system is incorporated so that when a key is pressed, an audio device produces a single short-period beep.

Programming Section

This section of the keypad contains 12 keys arranged in an matrix. Keys 1,2,3,5,6,9 and CLEAR have three levels; the OFF key has one level; and the remainder have two levels.

a. The first level represents function parameters. These functions are printed in black lettering on a grey background.(eg. TIME, ERROR, etc.).

b. The second level also represents function parameters. These are also shown in black lettering on a grey background between the function and numeric descriptors(eg. DATE, DATUM, and GRAD).

c. The third level consists primarily of numbers printed in red or white on a grey background. The numbers are accessible by using the CHANGE/ENTER keys.

The OFF key is a single level with only one function.

NOTE

The first and second levels form a toggle type push button. Consecutive operations of the push button activates the alternate selection.

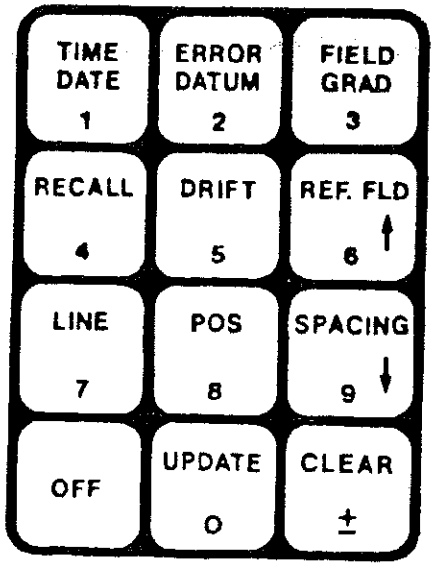

Figure 4-3 Programming Keypad

KEY	FUNCTION
TIME DATE 1	When this key is pressed once, the current time of day (ie, 24 hour real-time clock) will be displayed in hours, minutes and seconds (HH:MM:SS). The time is not updated automatically on the display, instead it displays the time of measurement during the survey. When the key is pressed a second time, the date will be displayed in year, month, day (YY:MM:DD) [note: The clock does not have a leap year compensation]. When changing the date, the time must also be re-entered in order to enter the new date in the real-time clock.

Table 4-2
Programming Section

KEY	FUNCTION
TIME DATE 1	When any displayed parameter requires changing and the CHANGE key is pressed, the TIME key becomes a numeric key with a value of 1.
ERROR DATUM 2	When the key is pressed once, the statistical error of the current magnetometer reading will be displayed in gammas, with a resolution of 0.01 gammas.

NOTE

To display the statistical error, the ERROR key may be pressed at any time to obtain a first time display or for display recall purposes.

When the key is pressed a second time, a datum value can be entered. This datum number allows the operator to remove a value from the magnetometer total field readings that is constant with all the readings. This datum value will be substracted from the total field readings during the dumping process.

When any displayed parameter requires changing and the CHANGE key is pressed, the ERROR key becomes a numeric key with a value of 2.

Table 4-2
Programming Section

KEY	FUNCTION
FIELD GRAD 3	The FIELD and GRAD selections may be considered as a toggle switch. When this key is pressed once, the magnetometer total field reading will be displayed, expressed in gammas.

NOTE

When the instrument requires manual tuning, a total field value is entered through this function key. By pressing the CHANGE/ENTER keys, a numeric value similar to the local total field may be entered.

When the GRAD mode has been selected and this key is pressed, the display first indicates the magnetometer total field reading taken by the upper sensor. When the key is pressed again, it toggles to the GRAD selection and displays the vertical gradient in gammmas/meter. The gradient is calculated and displayed using a 0.5m spacing which cannot be changed.

NOTE

When in the GRAD mode, the total field or the vertical gradient will be displayed depending on what function was last viewed prior to storing a reading.

When any displayed parameter requires changing and the CHANGE key is pressed, the FIELD key becomes a numeric key with a value of 3.

Table 4-2
Programming Section

KEY	FUNCTION
RECALL 4	This selection allows the operator to manually access data stored in memory. When the RECALL key is pressed, keys 6 and 9 can be used to scroll the memory in order to display previous records. Key 9 decrements the record location; key 6 increments it. In recall, any stored parameter (ie, date; time; line; position; error; magnetometer total field; vertical gradient; VLF total field intensity, primary field direction, vertical quadrature and in-phase for each of the three VLF frequencies selected or cultural features) can be displayed by pressing the appropriate function key. **NOTE** During recall, the decay and sensor descriptors will all be flashing to distinguish between parameters displayed in normal operation and those displayed in recall. When any displayed parameter requires changing and the CHANGE key is pressed, the RECALL key becomes a numeric key with a value of 4.
DRIFT 5	When this key is pressed once, the change in reading between the two most recent magnetometer total field readings is displayed. When the key is pressed again, it indicates the magnetometer field variation between the two most recent tie points. When any displayed parameter requires changing and the CHANGE key is pressed, the DRIFT key becomes a numeric key with a value of 5.

Table 4-2
Programming Section

KEY	FUNCTION
REF.FLD 6	When this key is pressed in the base station or tie-line mode, a programmable magnetometer total field value can be entered. This value is then subtracted from the raw magnetometer base station data to obtain the drift or diurnal correction which is to be applied to the total field data. The reference field is also used for the drift or diurnal correction if the unit is used as a tie-line magnetometer. When the MODE key is pressed, this key ( ) increments the mode descriptors. The key must be pressed each time to scroll through the various mode selections. When the SPECIAL key has been selected, this key ( ) increments through the 99 culture codes. When the key is held, it scrolls the features in the fast forward direction. When RECALL has been selected, the key ( ) increments the memory location. When the key is held, it scrolls the memory in the fast forward direction.
LINE 7	When this key is pressed once, the current line number will be displayed. This is a four digit number and can be either positive or negative. When any displayed parameter requires changing and the CHANGE key is pressed, the LINE key becomes a numeric key with a value of 7.
POS 8	When this key is pressed once, the current position or station number will be displayed. This is a four digit number and can be either positive or negative. When any displayed parameter requires changing and the CHANGE key is pressed, the POS key becomes a numeric key with a value of 8.

Table 4-2
Programming Section

KEY	FUNCTION
SPACING 9	Used in field survey applications, when this key is pressed, the spacing between the lines or positions is displayed.

NOTE

When line or position spacing is displayed, the descriptor INTV(interval) appears on the right of the display. This enables the operator to differentiate between a line or position number display and a line or position spacing display.

To obtain the position (station) spacing:

The POS key is pressed first followed by the SPACING key.

To obtain the line spacing:

The LINE key is pressed first followed by the SPACING key.

In base station applications, (ie, AUTO mode), after first pressing the TIME key, the SPACING key displays the current programmed sampling interval (ie, set between 5 seconds and 60 minutes). Time spacing is also used for the field magnetometer if synchronization is required between the base station and field units. If it is not required, this feature is disabled by entering 0000 for the time spacing in the field unit.

When the MODE key is pressed, this key ( ) decrements the mode descriptors. The key must be pressed each time the operator wants to scroll through the mode descriptors.

When the SPECIAL key has been selected, this key ( ) decrements through the 99 culture codes. When the key is held, it scrolls the codes in the fast backwards direction.

Table 4-2
Programming Section

KEY	FUNCTION
SPACING 9	When RECALL has been selected, this key ( ) decrements the memory location. When the key is held, it scrolls the memory in the fast backwards direction. When any displayed parameter requires changing and the CHANGE key is pressed, the SPACING key becomes a numeric key with a value of 9.
UPDATE 0	The main function of this key is to update the line number in the survey grid. When the LINE key followed by the UPDATE key are pressed, the line number will be automatically updated by the programmed line spacing. **NOTE** When the UPDATE key is pressed other than when preceeded by the LINE key, as a default, the position number will be incremented or decremented automatically by the programmed position spacing and sign. To update the previous position number, the operator may also press the POS key first. The display will indicate the last stored position number. When the UPDATE key is pressed, the displayed position number is updated by the programmed position spacing increment. When any displayed parameter requires changing and the CHANGE key is pressed, the UPDATE key becomes a numeric key with a value of 0.

Table 4-2
Programming Section

KEY	FUNCTION
CLEAR + -	In any of the manual modes, (ie, TIE, TFM, GRAD), if the RECALL key is pressed, the most recent reading, will be displayed. Then, if the CLEAR key is pressed, that reading is deleted from the memory. No other reading can be deleted. In the DUMP mode, if HP8888 is entered and the CLEAR key is pressed it clears the tie-line memory of all tie-line data. When the CHANGE key is pressed, the CLEAR key becomes a mathematical key with a ± toggle application to change the sign. **NOTE** **Only the negative sign is displayed. The positive sign is replaced by a space or blank.**
OFF	When this key is pressed, it commands the instrument to turn off the power. The power-down sequence is under computer control to ensure an organized shut-down. **NOTE** The OMNI-PLUS shuts down automatically after approximately 45 seconds if no keys are pressed. The OFF may be used to override the normal 45 second display time-out period to conserve battery power any time.

Table 4-2
Programming Section

Recording-VLF Section

This section contains 10 keys in a matrix. The keys are divided into four categories and are distinguished by their background colour sequence.

The READ key has black lettering on a red background. This key activates the instrument for all functions.

The TIEBASE-SPOT, MULTI and AUTO RECORD keys enable the operator to take magnetometer total field, gradient and/or VLF readings and record the data in a choice of three different ways depending upon the survey grid configuration established. These keys are designated by the black lettering on a white background.

The keys with the black lettering on a blue background allow the user to program and view the VLF parameters. These VLF parameters are for both the magnetic and electric components of the VLF.

The **CHANGE** and **ENTER** keys allow the user to change the numeric value of any of the keys on the programming keypad. These keys are designated by the black lettering on a dark gray background.

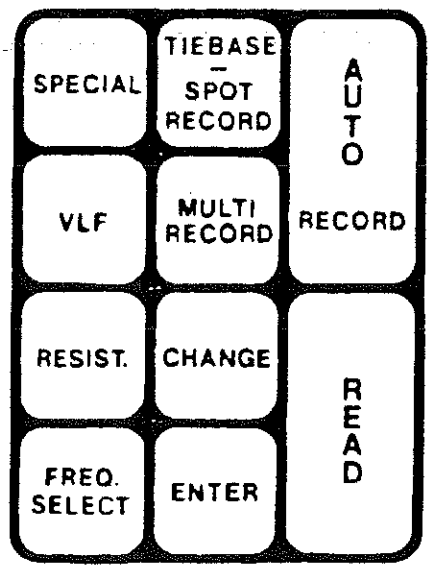

Figure 4-4
Recording-VLF Section

KEY	FUNCTION

NOTE

The TIEBASE-SPOT RECORD, MULTI RECORD and AUTO RECORD keys are single level keys with a built-in safety mode. Each key has to be pressed twice (sequentially) before any data can be stored. Following a data dump sequence, and when the operator attempts to store the very first reading again using the TIEBASE-SPOT RECORD, MULTI RECORD or AUTO RECORD keys, the instrument will refuse to store the data block unless the software code plus an operator code number has been entered.

READ — When this key is pressed, it commands the instrument to turn on its power. First, the computer initializes itself, then the setting of the MODE key is read. The computer program then proceeds with routines on the basis of the MODE selected. Then the OMNI-PLUS takes a reading of the magnetometer total field and up to three VLF frequencies. The magnetometer total field reading is displayed followed by the total field intensity value of the first VLF station being measured. These readings can then be stored using one of the three RECORD methods.

TIEBASE – SPOT RECORD — This record key has two functions:

a. When the instrument is in the TFM or GRAD mode, the information is stored together with a record pointer number. There is no indication of the grid coordinates (ie, line or position number). Following a data dump, the first spot record becomes 0001. This is incremented with each new reading. A prefix RP becomes assigned to the record point. This RP number becomes assigned automatically to the data to be stored in memory.

Table 4-3
Recording-VLF Section

KEY	FUNCTION

When the number is displayed, it allows the operator to record this number, on a map or chart for example, for cross-reference later when required. The new data will not be stored in memory yet. To store the data under the displayed record pointer, the SPOT RECORD key must be pressed a second time. In response, the instrument stores the data, then it switches itself off immediately.

b. When the instrument is in the TIE mode, the magnetometer total field reading and the total field reading of the three VLF stations is stored in the separate tie-line memory. These values are then used to calculate the diurnal and primary field variations of the magnetic and VLF readings respectively.

At a base reference point, a reading is taken and the TIEBASE-SPOT RECORD key is pressed. The record number LP9999 is displayed on the LCD display. To store the data under this location, the TIEBASE-SPOT RECORD key must be pressed a second time. In response, the instrument stores the data, then it switches itself off immediately.

MULTI RECORD This key is used to store many readings at one station without updating the station coordinates. The multiple entries are similar to the SPOT RECORD entry except that the coordinates are repeated. At the appropriate grid coordinate, the READ key must be pressed to obtain the magnetometer total field and VLF readings. These readings are displayed on the LCD. When the MULTI RECORD key is pressed once, the position number will be displayed. To store the data under the current grid coordinates, the MULTI RECORD key must be pressed a second time. In response, the instrument stores the data, then it switches itself off immediately. Repeat readings can be taken and stored by pressing READ, then MULTI RECORD twice. However, the data printout will show these readings keyed to same grid coordinates (ie, the coordinates do not increment in this multi record mode).

Table 4-3
Recording-VLF Section

KEY	FUNCTION
	With the MODE key set to TIE, this key functions in the same way, except that the default parameter displayed is the LINE instead of the POSITION.
A U T O RECORD	This key is used in two modes: Tie line measurements; and field survey measurements. a. When TIE is selected and a reading is taken, the line number is incremented automatically by the programmed line spacing increment. b. When TFM or GRAD is selected and a reading is taken, the position number is incremented automatically by the programmed position spacing increment. At the appropriate grid coordinate, the READ key must be pressed to obtain the magnetometer total field reading and VLF readings. The magnetometer total field reading followed by the total field intensity value of the first VLF station are displayed on the LCD. When the AUTO RECORD key is pressed once, the position number will be displayed (in the TIE mode, the line number will be displayed). The position value has been automatically updated from the previous station by the spacing programmed (in the TIE mode, this applies to the line value). To store the data under the current grid coordinates, the AUTO RECORD key must be pressed a second time. In response, the instrument stores the data and then it switches itself off immediately. **NOTE** If it is required to change the displayed coordinate this can be done before the key is pressed for the second time because the data will not have been stored in memory yet.

Table 4-3
Recording-VLF Section

KEY	FUNCTION
CHANGE	When the CHANGE key is pressed, two functions are initiated: (i) The keypad function keys are changed to the red or white numeric values located on the programming section of the keypad. (ii) The values of the following parameters can be selected, displayed and changed individually: Time; date; datum; field, (for the purposes of tuning only); drift; ref. fld; line number and line spacing; position number and position spacing; instrument code; operator number; cultural codes; frequency selection (in TEST mode only); baud rate; and dump codes.
ENTER	This key enters the desired numeric data into memory and returns the selected function key to the function (black) level. This key can be pressed at any time, even while some digits are still flashing. When the audio warning is sounding and all digits are flashing, this key is disabled until after the CHANGE key is pressed first to turn off the audio warning.

Table 4-3
Recording-VLF Section

KEY **FUNCTION**

SPECIAL In any of the measurement modes, (ie, TIE, TFM, GRAD or VLF), a cultural feature stored in internal ROM or any number from 99 may be stored and later outputed with the reading measured to assist with interpretation of the data. The predetermined features and their corresponding numbers stored in internal ROM are as follows:

NUMBER	DISPLAYED	OUTPUTTED	FEATURE
00			Default-no feature displayed
01	bASE01	BASE	base line
02	tiE 02	TIE	tie point
03	PoSt03	POST	claim post
04	inCL04	INCL	incline
05	dECL05	DECL	decline
06	CLiF06	CLIF	cliff
07	boG 07	BOG	bog(swamp)
08	Pond08	POND	pond
09	riUr09	RIVR	river
10	HiLL10	HILL	hill
11	CLAY11	CLAY	visible clay
12	CroP12	CROP	outcrop
13	roAd13	ROAD	road
14	HYdr14	HYDR	hydro line
15	trAn15	TRAN	transmission line
16	LAhE16	LAKE	lake
17	CrEC17	CREC	creek
18	rAU 18	RAV	ravine
19	ridG19	RIDG	ridge
20	tEL 20	TEL	telephone line
21	rAiL21	RAIL	railway line
22	FEnC22	FENC	fence
23	PiPE23	PIPE	buried pipe
24	HoLE24	HOLE	drill hole
25	CAbL25	CABL	buried cable
26	brdG26	BRDG	bridge
27	bLdG27	BLDG	building
28	roCh28	ROCK	rock(boulder)
29	05529	S5	slope of +5 degrees
30	10530	S10	slope of +10 degrees
31	15531	S15	slope of +15 degrees

Cultural Features
Table 4-3
Recording-VLF Section

KEY NUMBER	FUNCTION DISPLAYED	OUTPUTTED	FEATURE
32	20532	S20	slope of +20 degrees
33	25533	S25	slope of +25 degrees
34	30534	S30	slope of +30 degrees
35	35535	S35	slope of +35 degrees
36	40536	S40	slope of +40 degrees
37	45537	S45	slope of +45 degrees
38	-05538	-S5	slope of -05 degrees
39	-10539	-S10	slope of -10 degrees
40	-15540	-S15	slope of -15 degrees
41	-20541	-S20	slope of -20 degrees
42	-25542	-S25	slope of -25 degrees
43	-30543	-S30	slope of -30 degrees
44	-35544	-S35	slope of -35 degrees
45	-40545	-S40	slope of -40 degrees
46	-45546	-S45	slope of -45 degrees
47	nort47	NORT	North designation
48	Sout48	SOUT	South designation
49	EASt49	EAST	East designation
50	WESt50	WEST	West designation
51	U12C51	V12C51	Software eprom code
52	52	52	numbers may be
'	'	'	used to note
'	'	'	a feature not
99	99	99	specified

Cultural Features

Table 4-3
Recording-VLF Section

After a reading is taken, the SPECIAL key is pressed displaying 00. The desired code may be selected by using the scroll keys (programming keys 6 and 9) or by using the CHANGE key and selecting the number of the desired feature (ie, 20=TEL). The feature is stored when the measured data is recorded using one of the record keys (ie, AUTO RECORD).

NOTE

After a reading is stored and the instrument shuts off,the SPECIAL key will automatically default to 00.

Table 4-3
Recording-VLF Section

KEY	FUNCTION
VLF	The VLF key is a scrolling key that allows the operator to view the VLF magnetic parameters stored for each of the three stations measured. Presently, only the following parameters are displayed and stored: In-phase, vertical quadrature, total field intensity and vertical dip angle. To view a specific parameter, the frequency key (FREQ. SELECT) is used to choose the desired station. The VLF key is pressed displaying the in-phase component of that particular station. To view the other parameters, the VLF key is pressed until the desired parameter is displayed.
RESIST.	The RESIST. key is a scrolling key that allows the operator to view the VLF electric parameters stored for each of the three stations measured. Presently, the features displayed and stored are magnetic primary field direction, apparent resistivity and phase angle.

Table 4-3
Recording-VLF Section

KEY	FUNCTION

FREQ. SELECT The FREQ. SELECT key is used to program and view the VLF stations desired. Any frequency between 15.0 and 30.0 kHz may be used in 0.1 increments. Noted below are some of the more commonly used VLF stations and their corresponding frequencies:

STATION	LOCATION	kHz	POWER	MAINTENANCE
FUO	Le Blanc, France	15.1	500 kW	
GBR	Rugby, United Kingdom	16.0	750	Tues. 1000-1400
JXZ	Hegeland, Norway	16.4	350	
	France	16.8		
UMS	Moscow, U.S.S.R.	17.1	1000	
NDT	Yosami, Japan 34 58' 15" N 137 01' 18" E	17.4	50	2300-0900 First Thu-Fri of Month 2300-0700 all other Thu-Fri
	Criggeon United Kingdom	19.0		Wed.
GBZ	Oxford, United Kingdom	19.6		
NSS	Annapolis, Maryland USA 38 59' 30" N 76 27' 10" W	21.4	400	Tues. 1200-2000 Testing 2000-2200 of Tues. Operator Training 1800-2000 2nd & 4th Thurs.
NWC	Exmouth, Australia Australia 21 49' 01" S 114 09' 50" E	22.3	1000	Mon. 0000-0800 If Mon holiday, then Tues. May be off Tues 0000-0400
	Rhauderfehn, West Germany	23.4		
NPM	Lualualei, Hawaii 21 25' 30" N 158 09' 20" W	23.4	600	1800-0400 last Wed-Thur of Month 1800-0200 all other Wed-Thur.

VLF Transmitting Station Schedule
Table 4-3
Recording-VLF Section

STATION	LOCATION	kHz	POWER	MAINTENANCE
NAA	Cutler, Maine,USA 44 38' 50" N 67 16' 54" W	24.0	1000	Mon. 1200-2000 Testing 2000-2200 each Mon. If hoilday on Mon, then preceeding Fri. Operator training 1800-2000 1st, 3rd & 5th Thur.
NLK	Jim Creek, Washington, USA 48 12' 15" N 121 55' 00" W	24.8	125	Thurs.1600-2400 1500-2300 during daylight savings time.
NAU	Aguada, Puerto Rico	28.5	100	Wed. 1200-2000

All times are in Greenwich Mean Time

VLF Transmitting Station Schedule

NOTE

EDA Instruments will have a weekly maintenance schedule of stations for the North American area. Please contact EDA Instruments if specific information is required.

In different parts of the world, there may be VLF transmitting stations not listed in the above schedule. Use the spectrum feature described in Section 9 to determine other usuable VLF frequencies.

The following figures (Figure 4-5 to 4-7) show the locations of the major VLF transmitting stations and the estimated total field intensity values for the OMNI-PLUS. Data for total field intensities of 2 or greater should be satisfactory. However, satisfactory information has been obtained from data where the total field intensity has been between 1 and 2.

Table 4-3
Recording-VLF Section

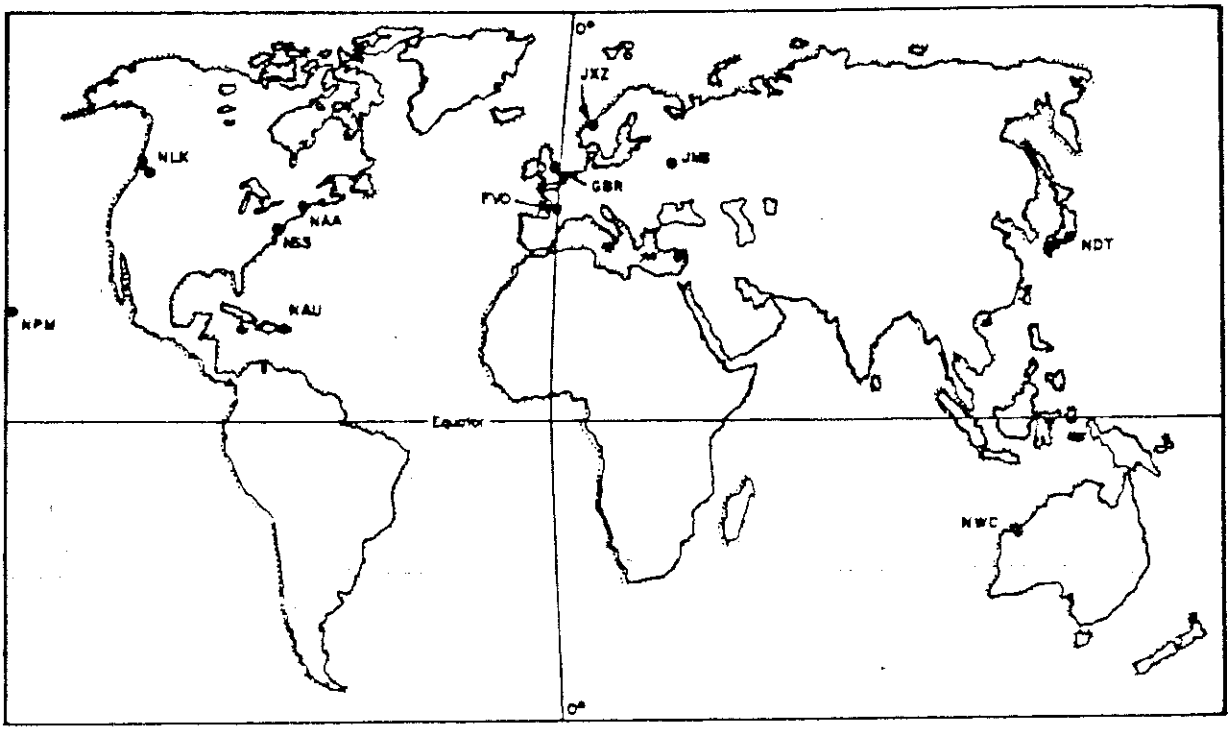

Figure 4-5
Map of VLF Transmitting Station Locations

Figure 4-6
VLF Total Field Strengths For North America
Cutler, Maine, USA 24.0 kHz

Figure 4-7
VLF Total Field Strengths For North America
Annapolis, Maryland, USA 21.4 kHz

Figure 4-8
VLF Total Field Strengths For North America
Jim Creek, Washington, USA 24.8 kHz

Figure 4-9
VLF Total Field Strengths For North America
Aguada, Puerto Rico 28.5 kHz

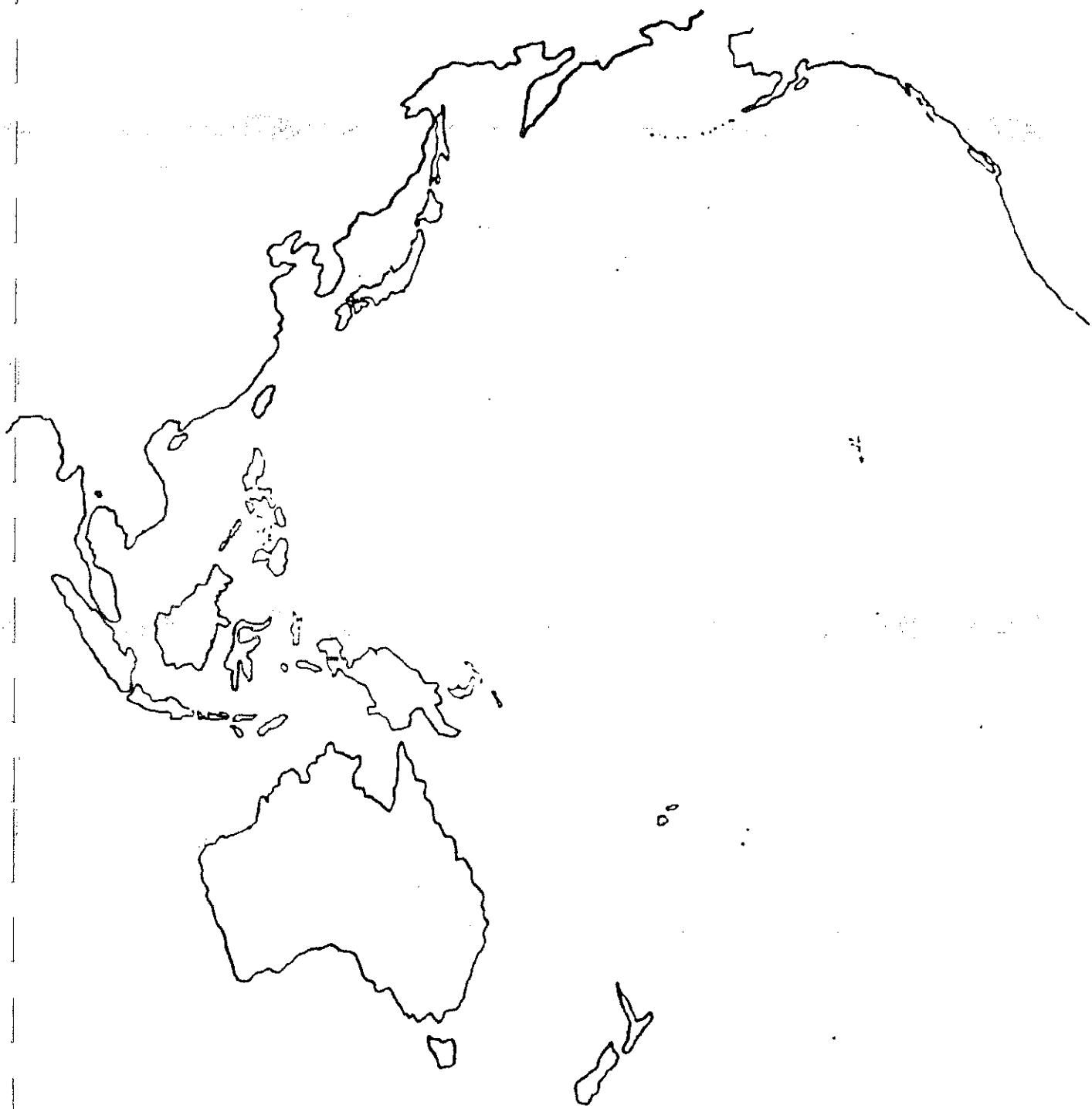

Figure 4-10
VLF Total Field Strengths For North America
Lualualei, Hawaii, USA 23.4 kHz

Figure 4-11
VLF Total Field Strength
Criggeon, United Kingdom 19.0 KHz

Figure 4-12
VLF Total Field Strength
Rugby, United Kingdom 16.0 KHz

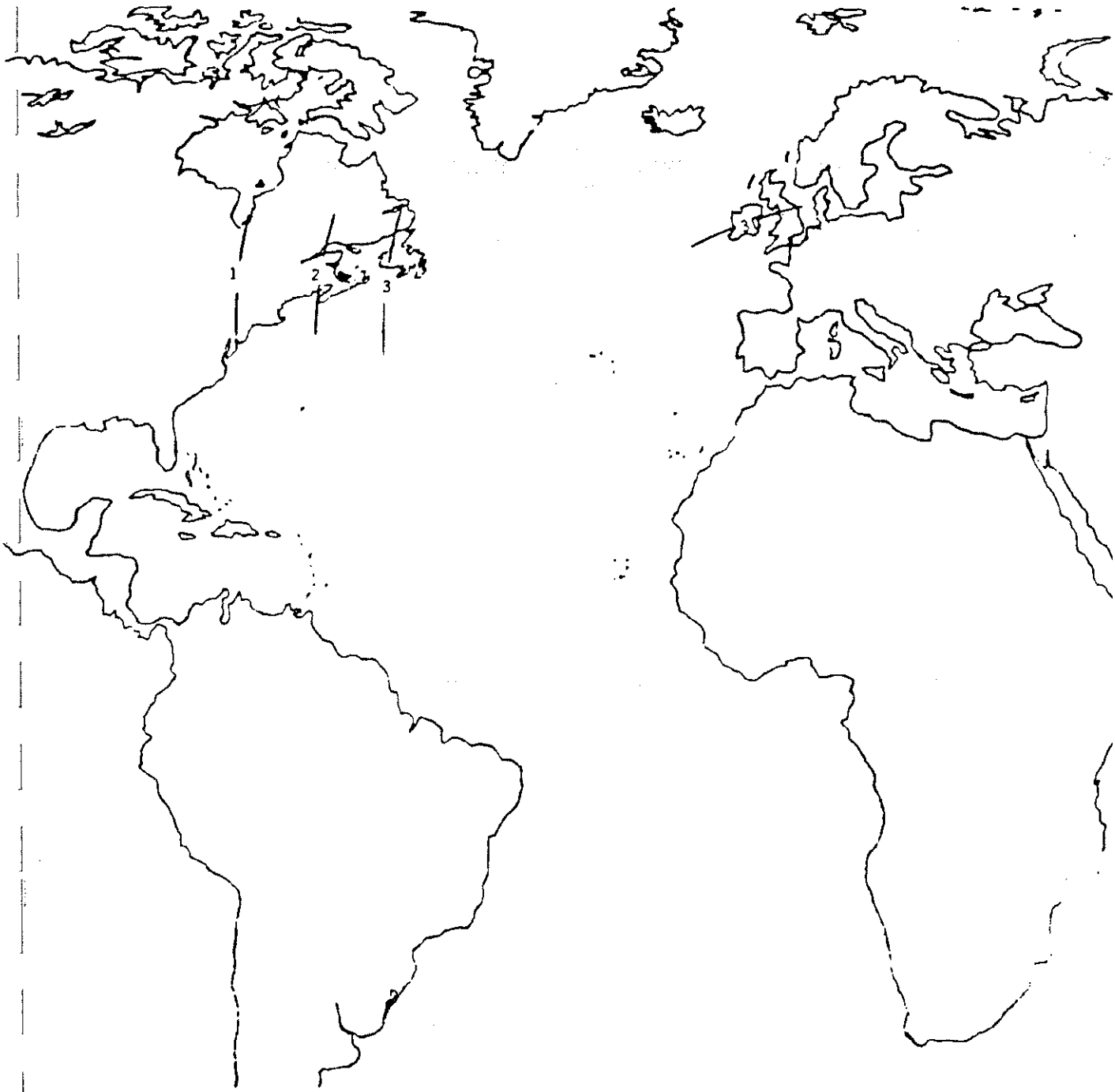

Figure 4-13
VLF Total Field Strength
Le Blanc, France 15.0KHz

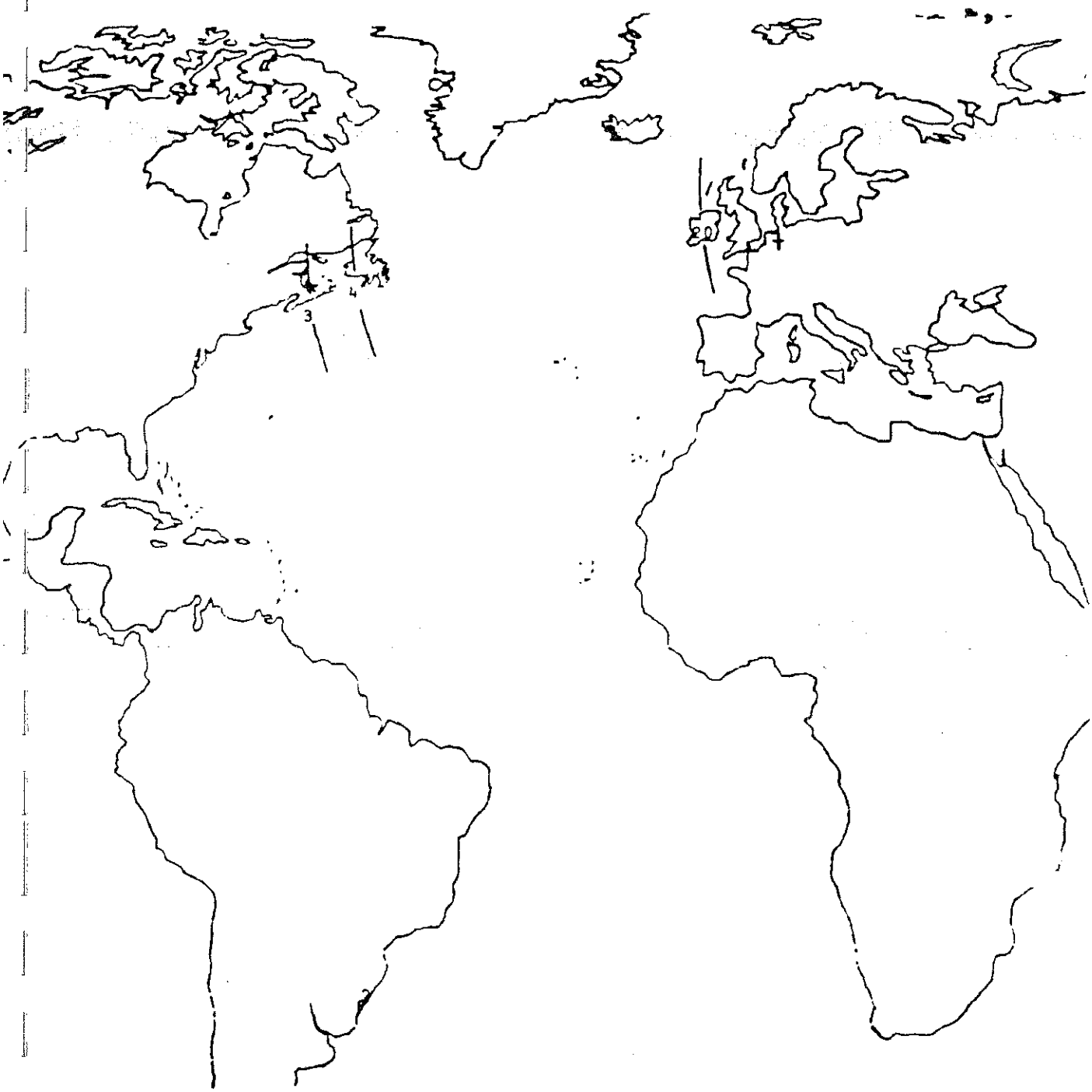

Figure 4-14
VLF Total Field Strength
Rhauderfehn, West Germany 23.4 KHz

Figure 4-15
VLF Total Field Strength
Hegeland, Norway 16.4 Kz

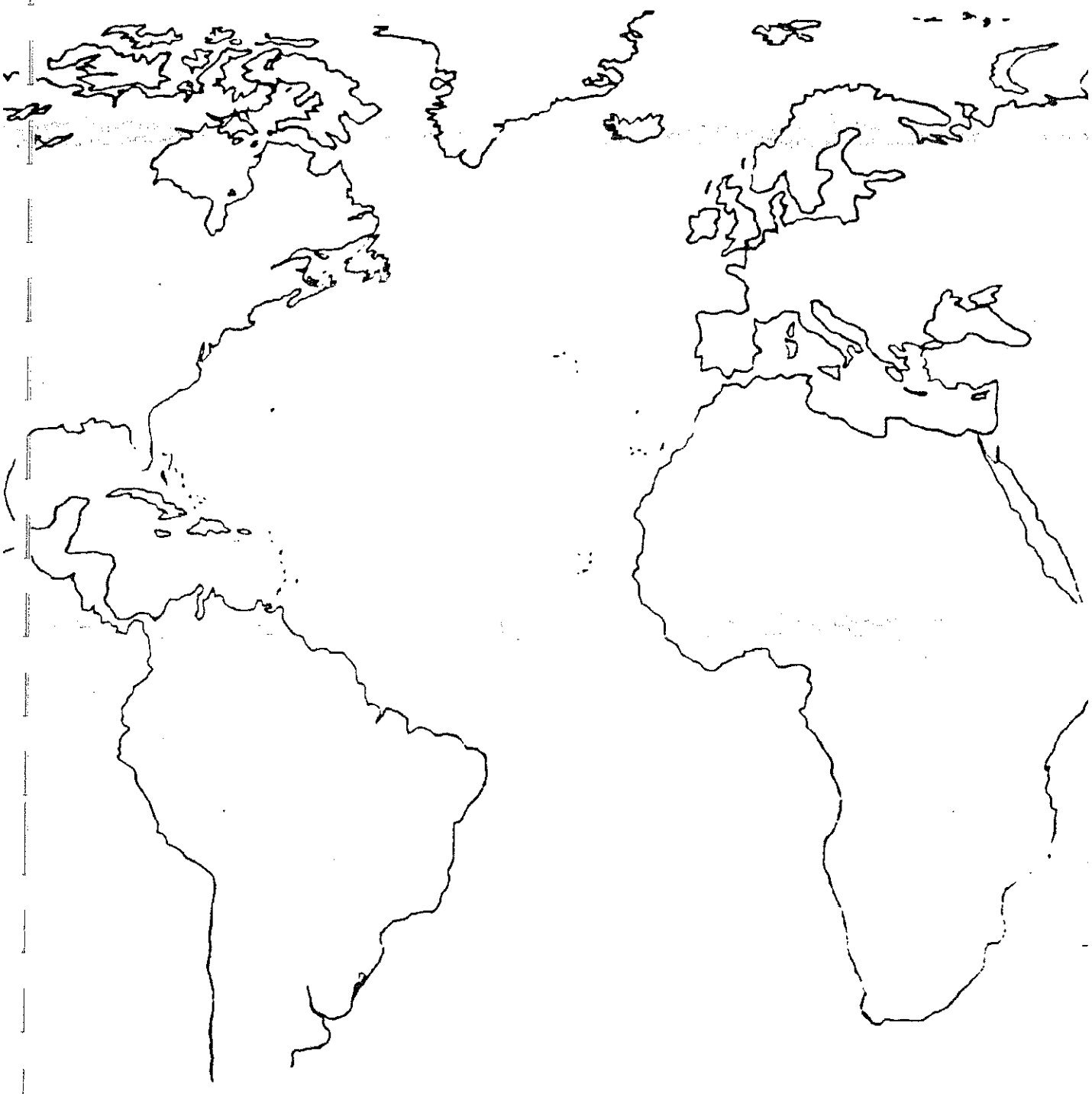

Figure 4-16
VLF Total Field Strength
Oxford, United Kingdom 19.6 KHz

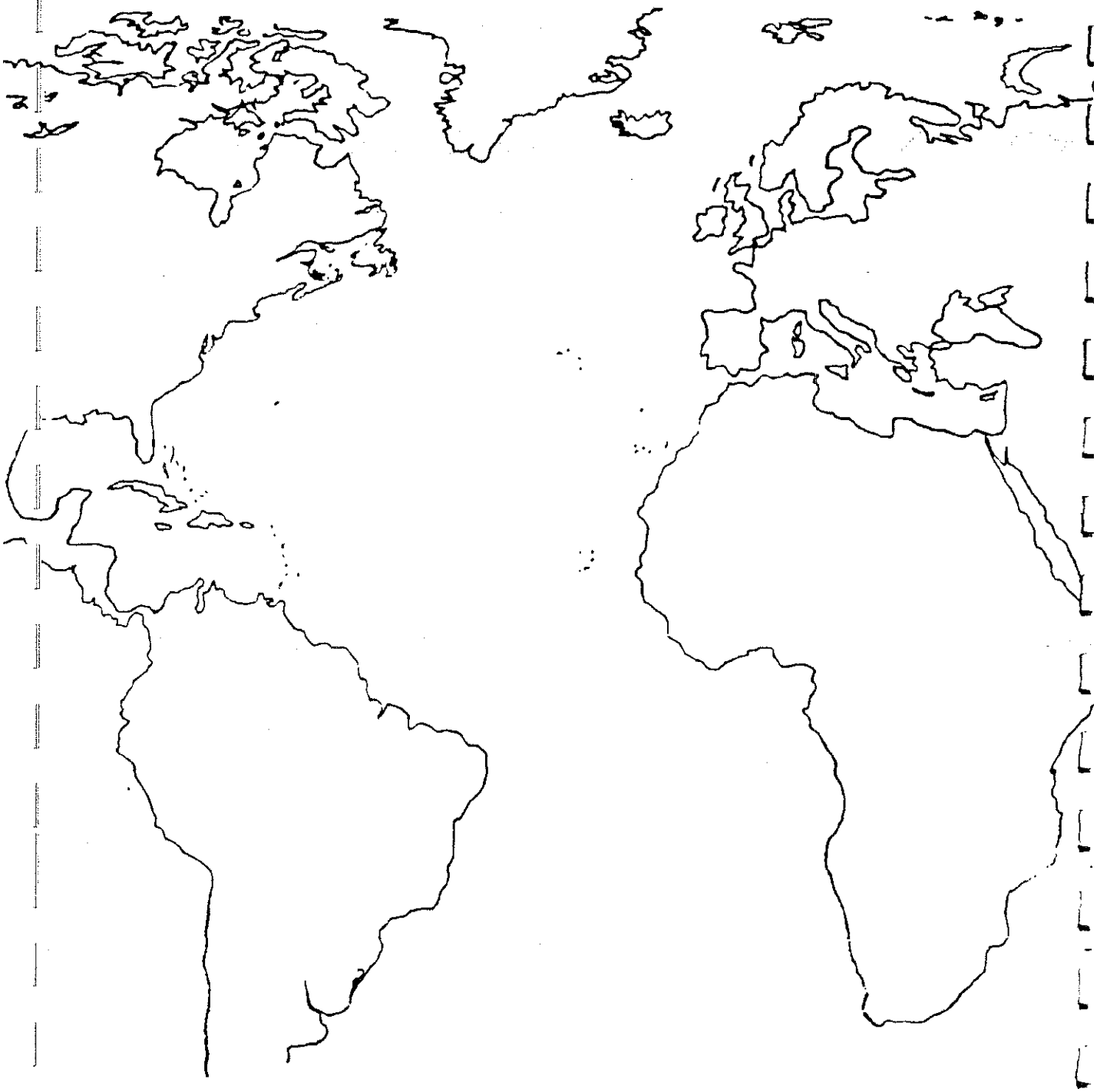

Figure 4-17
VLF Total Field Strength
Chateau Roux, France 16.8 KHz

Figure 4-19
VLF Total Field Strength
Yosami, Japan 17.4 KHz

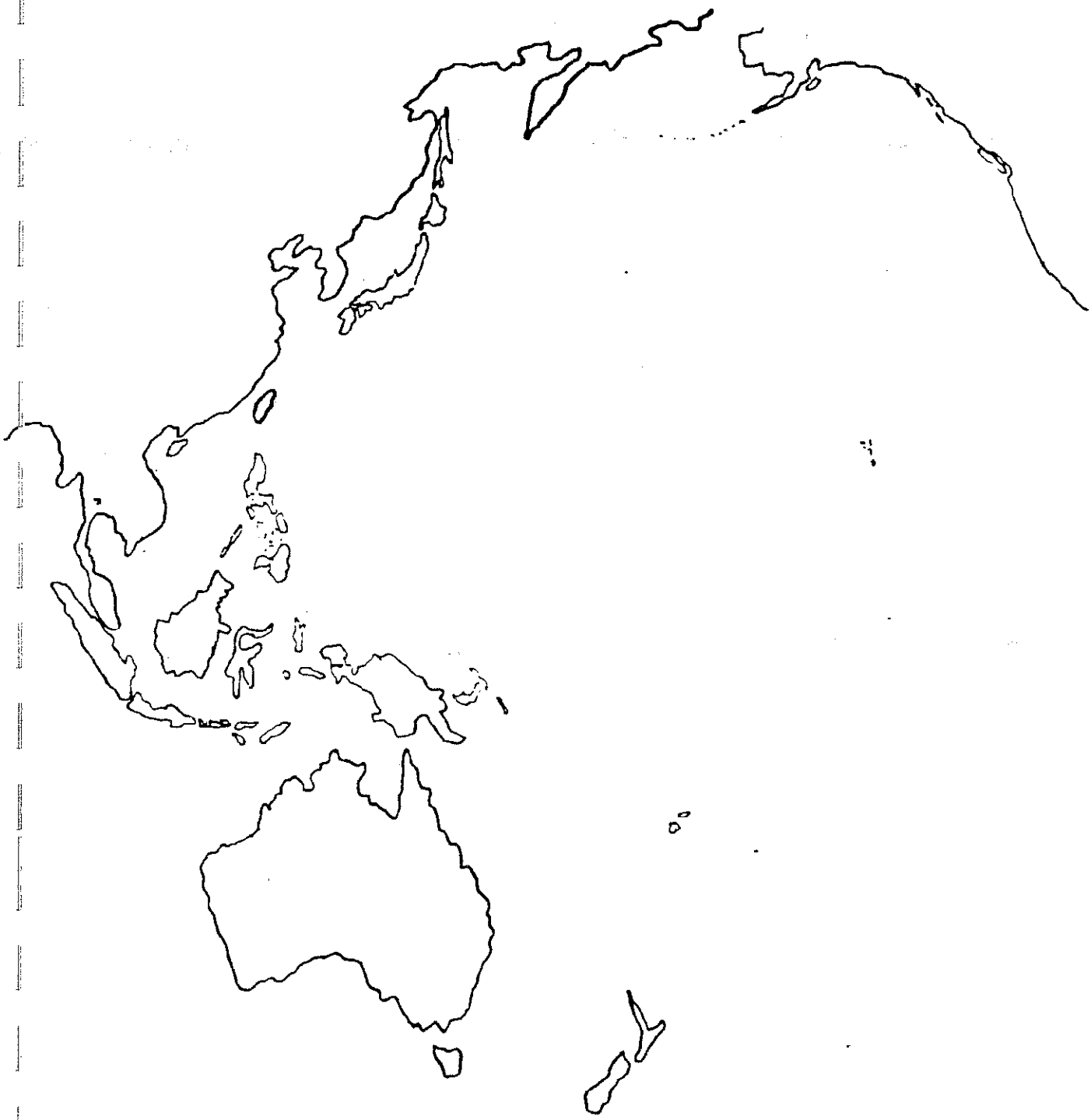

Figure 4-20
VLF Total Field Strength
Exmouth, Australia 22.3 KHz

4.5 LIQUID CRYSTAL DISPLAY (LCD)

The display is a custom-designed, ruggedized, high-quality, liquid crystal display. It utilizes a fluid which allows the display to be operated in temperatures as low as -35 degrees Celcius without any heating. However, at -30 degrees Celcius, there is already a significant segment turnover slow-down. A safety margin is provided by incorporating a heater system which turns on at about -25 degrees Celcius. During prolonged low temperature operation, the heater circuitry remains on even when the power to the instrument is switched off, provided that the MODE key is not set to OFF.

NOTE

When the ambient temperature is lower than -25 degrees Celcius and the OMNI-PLUS is not in use for a while, it is recommended that the MODE key be set to the OFF position. This action prevents continuous battery power drain. The display comprises of eight mode descriptors (described in Section 4.3); ten individual descriptors; three bar and wedge graphic indicators; and the primary numeric readout. The numeric readout consists of six digits; two colons which separate the digits into three pairs; and two individual decimal points which indicate tenths or hundredths. Refer to Figure 4-21.

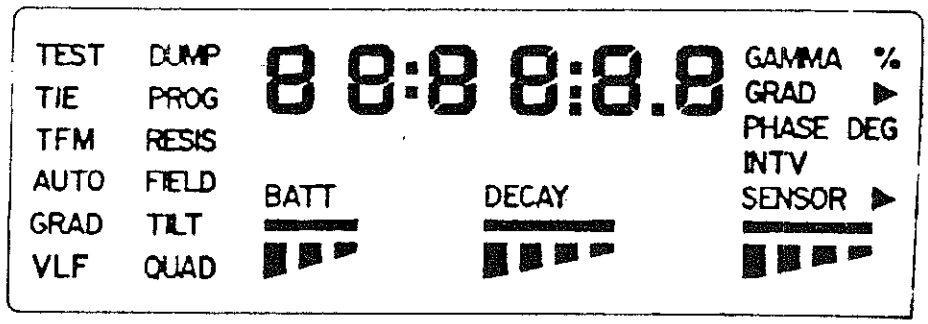

Figure 4-21
Liquid Crystal Display (LCD)

Description	Function
%	The descriptor % will be displayed when the VLF quadrature (QUAD) or the in-phase (PHASE) value is displayed. This is to denote that the values displayed are in percent.
DEG	The descriptor DEG will be displayed when the VLF primary field direction or the VLF resistivty phase angle (RESIS PHASE)is displayed. This is to denote that the values displayed are in degrees.
BATT	The word BATT will be displayed during normal operation. It indicates that adequate power remains in the battery system. When BATT commences to flash on and off, the operator is warned that the battery is approaching the discharged condition rapidly. When the audio alarm is activated, the battery must be changed or charged. No further readings are possible. The battery monitor comprises the BATT descriptor, a rectangle and three wedge-shaped bars. With a fully charged battery system, all three bars are displayed. Gradually, after many readings, the residual battery power decreases. This is indicated when the left hand bar disappears. With continued battery discharge, the second bar disappears, followed eventually by the third bar. When this condition occurs, the battery is almost depleted. Therefore, it is recommended that the battery system be recharged or replaced when the BATT descriptor commences to flash on and off. The instrument inhibits any further readings when the BATT descriptor flashes and the audio alarm is actuated.
DECAY	The word DECAY will be displayed during normal operation of the magnetometer component of the system. When the word commences to flash on and off, it indicates that the decay rate of the precession signal is too fast due to large local gradients or a malfunctioning sensor.

Table 4-4
LCD Descriptors

Description	Function
RESIS	The word **RESIS** will be displayed when viewing the apparent resistivity value of any of the VLF stations. To view the resistivity value,the RESIS. key is pressed.
FIELD	The word **FIELD** will be displayed when the actual total field intensity value of any of the three VLF stations is displayed.
TILT	The word **TILT** will be displayed when the primary field direction of any of the three VLF stations is displayed.
QUAD	The word **QUAD** will be displayed when the vertical quadrature (out-of-phase) value of any of the three VLF stations is displayed.
GAMMA	The word **GAMMA** will be displayed when the actual magnetometer total field measurement or the test field reading is displayed. The word also appears when the ERROR key is pressed.
GRAD	The word **GRAD** will be displayed when the MODE is set to the GRAD position, and the gradient is displayed by pressing the FIELD/GRAD key. The word **GRAD** will also be displayed if the error of the gradient (lower) sensor is displayed.
PHASE	The word **PHASE** will be displayed when the in-phase value of any of the three VLF stations is displayed. The word **PHASE** will also be displayed when the phase angle value of the VLF electric component of any of the three VLF stations is displayed.
INTV	The word **INTV** (interval or spacing) will be displayed when the time interval, line or position spacing is displayed.

Table 4-4
LCD Descriptors

Description	Function

NOTE

A possible way to reduce the effect of the large local gradient is to raise the sensor.

The signal decay monitor comprises of the **DECAY** descriptor, a rectangle and four wedge-shaped bars. Every time that a reading is taken, the microprocessor calculates the actual decay rate. This is an important parameter because it reveals the degree of "gradient tolerance". When the decay rate is too fast due to large local gradients, the accuracy of the measurement is impaired to some degree. The statistical error value reveals this immediately. All four wedge shaped bars will be displayed when a normal decay rate is computed. When the operator gradually approaches a large local gradient, the computed decay rate increases, and the wedge-shaped bars may gradually disappear in sequence, from the left until the decay rate is too fast for proper signal processing. When this occurs, the **DECAY** descriptor commences to flash on and off and completion of the reading is inhibited. The reading is aborted.

At any time when VLF data is being displayed, the **DECAY** bars are used to monitor the operator quality for the measurement taken. During the measurement of the VLF frequencies ,the instrument monitors the movement and verticallity of the operator. Since the in-phase parameter is affected by these actions, the instrument gives an instantaneous visual output for the operator for up to three frequencies selected. As the operator quality decreases,the number of bars visible disappear from left to right. If the operator quality is unacceptable, the **DECAY** descriptor commences to flash on and off.

Table 4-4
LCD Descriptors

Description	Function
SENSOR	The word SENSOR will be displayed during normal operation. When the word commences to flash on and off, it indicates that the strength of the precession signal is below the minimum acceptable threshold. This condition may occur when: a. The sensor is damaged (fluid in sensor is depleted). b. A very large local gradient is encountered. c. Magnetic sensor is not properly aligned, especially in areas where the magnetic total field vector inclination angle is less than 45 degrees (ie, equatorial regions). d. If the base station is at a fast sample rate, the sensor may become warm .

The magnetometer sensor signal monitor comprises of the SENSOR descriptor, a rectangle and four wedge-shaped bars. Every time that a reading is taken, the microprocessor calculates the actual starting amplitude of the precession signal derived from the sensor. This monitor may be used to ensure that the sensor is aligned properly with magnetic North.

When the signal amplitude is normal and above a pre-defined threshold, all four wedge-shaped bars are displayed. If the calculated amplitude decreases, the bars disappear in sequence from the left until the amplitude does not meet the minimum threshold level. When this occurs, the SENSOR descriptor commences to flash on and off.

Table 4-4
LCD Descriptors

Description	Function
SENSOR	At any time when VLF data is being displayed, the SENSOR bars are used to monitor the actual signal/noise ratio for the frequencies selected. During the measurement of the VLF frequencies, the instrument monitors the signal being received on the particular frequency selected. The instrument gives the operator an instantaneous visual output of the signal/noise ratio for up to three frequencies selected. As the operator quality decreases, the number of bars visible disappear, from left to right. If the signal/noise ratio is unacceptable, the sensor descriptor commences to flash on and off.

Table 4-4
LCD Descriptors

SECTION 5

STEP-BY-STEP OPERATING PROCEDURES

5.1 PREPARATION FOR USE

Unpacking. Remove all components from the shipping containers and check the contents against the Packing Slip/Release Note. Report any shortages or damage immediately to EDA Instruments Inc.

5.2 ASSEMBLING INSTRUMENT FOR USE

The OMNI-PLUS consists of the following components:

- OMNI-PLUS Console
- VLF Module
- Battery Cartridge or Belt
- Interconnect Cable
- Magnetometer Total Field or Gradient Sensor
- Carrying Harness
- Battery Charger
- Pole Assembly

OMNI-PLUS Console. The OMNI-PLUS console delivered requires no assembly other than attaching the battery cartridge or belt. Figure 5-1 shows the rear of the console indicating the connectors and their use.

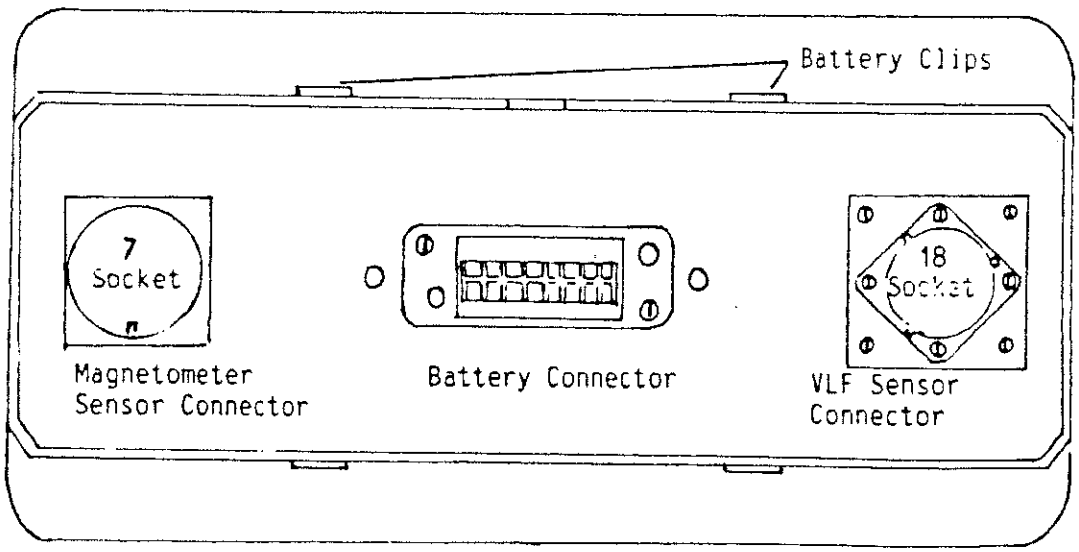

Figure 5-1
Rear View of OMNI-PLUS Console

Attaching Battery Cartridge. Align battery cartridge with the base of the console using the key at the base of the cartridge and the slot at the base of the console (see Figure 5-2). Secure the cartridge using the four plastic clips.

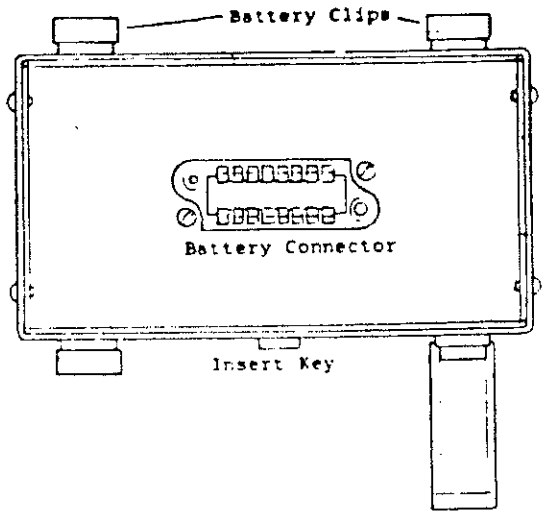

Figure 5-2
Attaching Battery Cartridge

Attaching Battery Belt. Align the battery belt connector with the battery connector at the base of the console using the two pins. Secure the battery belt connector using the two thumb screws (see Figure 5-3).

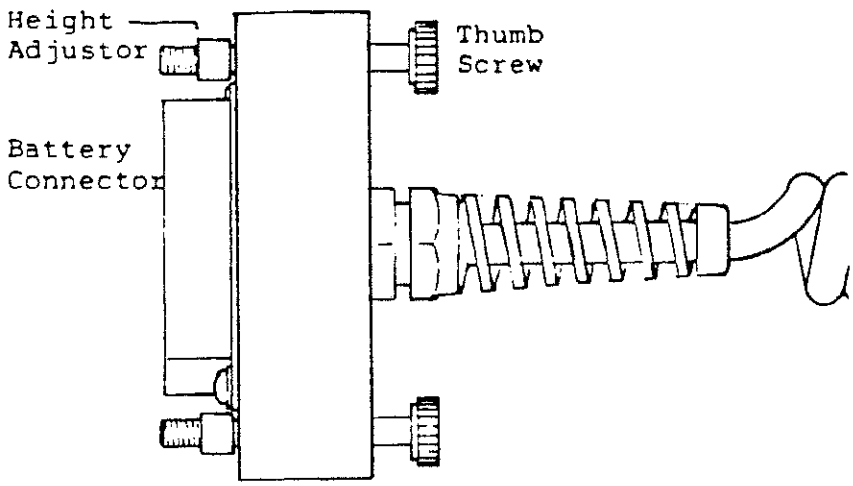

Figure 5-3
Attaching Battery Belt

Attaching VLF Sensor. The VLF sensor is connected to the console using the interconnect cable. This cable has two identical male KPT connectors at each end which attach to the corresponding female connectors on the VLF sensor and console. The connectors are keyed so they can only be inserted one way. To connect, push in aligning the keys and turn the outer ring until it clicks in. **PLEASE NOTE THAT THE CONNECTORS ARE LABELLED FOR VLF SENSOR AND OMNI-PLUS CONSOLE. ENSURE THAT THE CABLE IS CONNECTED PROPERLY.**

Attaching Magnetometer Sensor. Attach the cable connector to the corresponding female connector on the base of the console. (The VLF sensor connector and the magnetometer sensor connector are of different sizes so they cannot be switched accidentally). The connector is keyed so that the connector can only be inserted one way. Lock the connector in place by turning the outer threaded ring clockwise until firmly attached.

Mount the sensor on the top section of pole or staff. The end terminates in a tapered, threaded adaptor.

Connect the other pole sections in series with the white plastic end tip at the base of the pole.

Harness Setup. Figure 5-4 demonstrates the setup procedures to attach the various components of the OMNI-PLUS to the harness. Each component is held in place using the velcro pads. The strap buckles can be adjusted to suit the operator's preference. The Tri-glides are used to "lock" the buckles and straps in-place so no sliding or loosening of the straps occurs.

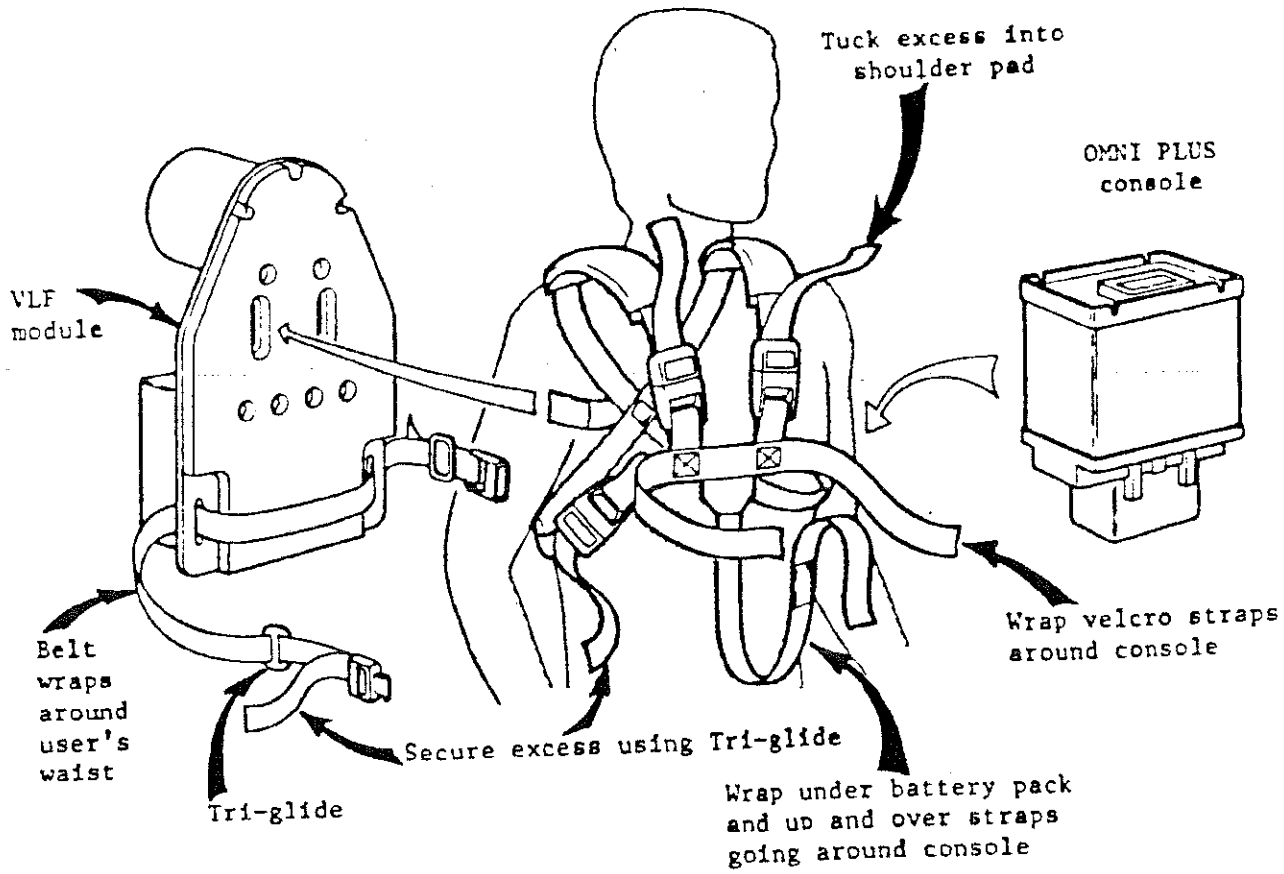

Figure 5-4
Harness Setup

5.3 OPERATING GUIDELINES

To obtain the best results, the following procedures must be adhered to:

(i) **Always stand straight.** Although the VLF sensor has tilt compensation, angles off vertical more than 10 degrees in either direction may affect the accuracy of the results.

(ii) **Stand still during the reading.** The OMNI-PLUS will measure the magnetometer total field , vertical gradient (if applicable), and up to three VLF stations in a period of five to eight seconds.* During this period it is important that the operator remains motionless so as to obtain the best results.

(iii) **Always face the direction you are walking.** The data is compensated for sign convention using the position spacing.

(iv) **Re-intialize the system when changing line direction more than 60 degrees.** Since the system has two horizontal coils that may be used as the reference coil, it is critical that the user re-intialize when changing line direction more than 60 degrees (ie, surveying along the baseline after surveying along the normal survey lines). See Section 9 for further details.

NOTE

This does not apply when the operator changes direction by 180 degrees (ie, when walking up and down the survey lines).

(v) **Hold the magnetometer sensor pole vertically at arm's length away from the console.** Holding the sensor off vertical can cause errors in the magnetic reading especially in the vertical gradient.

(vi) **Remove all metallic objects from the body.**

(vii) **Always orient the magnetometer sensor.** The sensor has north, south, east and west designations on it. Maintain the same orientation throughout the survey.

* **Note:** **This time period may vary due to the frequencies selected and the strength of the stations being measured. See Section 9 for further details.**

5.4 OPERATING PROCEDURES

(1) Programming-Individual Units

Press	**MODE**	On the display, all available modes are shown with the present setting flashing.
Press	**SPACING** **9**	Until TEST is flashing.
Press	**R** **E** **A** **D**	All modes except TEST will be deleted from the display. The test number 56369.7 will be displayed along with the battery strength indicator (BATT) and the descriptor GAMMA.

To Call Up The Date And Time

Press	**TIME** (twice) **DATE** **1**	A value YY:MM:DD will be displayed along with the TEST, GAMMA and BATT descriptors. Where: YY-year MM-month DD-day

If the date is correct, proceed to the next step (underlined).
If the date is incorrect:

Press	**CHANGE**	+ enter correct date using the red or white number keys. + **ENTER**

(1) Programming-Individual Units(con't)

To Call Up The Time

Press	**TIME** **DATE** **1**	A value HH:MM:SS will be displayed along with the TEST, GAMMA and BATT descriptors. Where: HH-hour MM-minute SS-second

If the time is correct, proceed to the next step (underlined).
If the time is incorrect:

Press	**CHANGE**	+ enter the correct time using the red or white number keys. + **ENTER**

Entering Grid Information

LINE

Press	**LINE** **7**	L NNNN will be displayed along with the TEST and BATT descriptors, where "N" is a numeric value.

If the line value is correct, proceed to the next step (underlined).
If the line is incorrect:

Press	**CHANGE**	+ enter the correct line value using the red or white number keys. + **ENTER**

Note: The line value entered should be your initial line for your survey.

(1) Programming-Individual Units(con't)

LINE SPACING

Press	**LINE** 7	**SPACING** 9	LNNNN will be displayed along with the INTV descriptor to deliniate between the line and the line spacing. The TEST and BATT descriptors are also displayed. The "N" is a numeric value.

If the line spacing is correct, proceed to the next step (underlined).
If the line spacing is incorrect:

Press **CHANGE** + enter the correct line spacing using the red or white number keys. + **ENTER**

Note: For 12.5m or 12.5ft spacings:

Press **CHANGE** + 0012 + **ENTER**

POSITION

Press	**POS** 8	P NNNN will be displayed along with the TEST and BATT descriptors. The "N" is a numeric value.

If the position value is correct, proceed to the next step (underlined).
If the position value is incorrect:

Press **CHANGE** + enter the correct initial position using the red or white number keys. + **ENTER**

(1) Programming-Individual Units(con't)

POSITION SPACING

Press	POS	SPACING	P NNNN will be displayed along with the INTV descriptor deliniating between the position and position spacing. The "N" is a numeric value.
	8	9	

NOTE

The sign of the position spacing is used to compensate the VLF data for sign convention. See Section 9 for further details.

If the position value is correct, proceed to the next step.
If the position value is incorrect:

Press **CHANGE** + enter the correct position spacing using the red number keys. + **ENTER**

Note: For 12.5m or 12.5ft spacing:

Press **CHANGE** + 0012+ **ENTER**

TUNING

Whenever a magnetic total field measurement is to be taken for the first time, it is necessary to enter in a value of the approximate field value for the area being surveyed.

To enter in a value:

Press		
	FIELD **GRAD** **3**	A six digit value will be displayed of the magnetic total field. Along with this value, the TEST, GAMMA and BATT descriptors will be displayed.

Press **CHANGE** + enter a six digit value corresponding to the local magnetic total field. + **ENTER**

NOTE

This value of the local magnetic field should be checked at the start of each day and/or any time when erractic readings occur.

Reading Synchronization

If it is required to synchronize the field unit with the base station unit, the time spacing for the field unit must be re-entered.

Press	**TIME**	A value HH:MM:SS will be displayed, where: HH-hour, MM-minute, SS-second
Press	**SPACING**	A value MM:SS will be displayed, where: MM-minute, SS-second
	9	

To synchronize with the base station unit, the time interval used on the base station unit must be entered into the field unit.

Press **CHANGE** + enter the time interval used on the base station + **ENTER**

NOTE

If no synchronization is required, enter a time interval of 00:00 in the field unit.

When the field unit is operated under one of the survey modes and the READ key is pressed, the unit will countdown and take a reading at the same time as the base station unit.

NOTE

Prior to implementing this feature, syncronize the base and field unit as per Section 2a, b or c.

(2) Programming a Base Station Unit

2 a) As an OMNI-PLUS Magnetometer Base Station

On the field and base units:

Press	**MODE**	On the display, all available modes are shown with the present setting flashing.
Press	**SPACING** **9**	Until TEST is flashing.
Press	**R** **E** **A** **D**	All modes except TEST will be deleted from the display. The test number 56369.7 will be displayed along with the battery strength indicator (BATT) and the descriptor GAMMA.
Press	**TIME** **DATE** **1**	A value YY:MM:DD will be displayed along with the TEST, GAMMA and BATT descriptors. Where: YY-year MM-month DD-day
Press	**CHANGE** +	enter correct time using the red or white number keys.
Press	**ENTER**	On both units **SIMULTANEOUSLY.**
Press	**OFF**	On both units.
Press	**R** **E** **A** **D**	All modes except TEST will be deleted from the display. The test number 56369.7 will be displayed along with the battery strength indicator (BATT) and the descriptor GAMMA.
Press	**TIME** **DATE** **1**	On both units **SIMULTANEOUSLY.** The time on both the field and base unit should be exact. If not repeat the above noted steps.

For the field unit, proceed as outlined in **Programming-Individual Units.**

On the base unit:

Press	R E A D	All modes except Test will be deleted from the display. The test number 56369.7 will be displayed along with the battery strength indicator (BATT) and the descriptor GAMMA.
Press	REF. FLD 6	NNNNN.N will appear along with the BATT, TEST and GAMMA descriptors, where "N" is a numeric value.

NOTE

This is your reference field to which the raw magnetometer base station data is subtracted from to obtain the drift or dicimal correction which is to be applied to the total field data. The reference field allows the operator to correlate day-to-day data to a common point or reference.

Press	CHANGE	+	enter value of local field uding the red or white numbered keys + enter
Press	FIELD GRAD 3		NNNNN.N will be displayed along with the TEST, BATT and GAMMA descriptors, where "N" is a numeric value.

NOTE

The value entered here is used by the instrument as a base to which the next reading is automatically tuned to. Therefore, the value entered here should be approximate to the local field.

At this point, the operator should proceed to the setup location for the base station and assemble the system. This location should be away from any cultural or natural source that may effect the magnetic fields.

Press	R E A D	A U T O	OPNNNN will be displayed along with the TEST and BATT descriptors, where "N" is a numeric value.

RECORD

NOTE

If OPNNNN does not appear, perform a dumping sequence as described on pages 6 (without being connected to a computer or peripheral).

Press **CHANGE** + **4MNN for BASE** + **ENTER**

where: M= 9 if alkaline batteries are used.
M= 0-8 if rechargeable batteries are used.
N= 0-7 for all three values. These three values are the operator code.

Press **A U T O** :NN:NN will be displayed along with the INN and TEST descriptors, where "N" is a numeric value.

RECORD

NOTE

If the time increment does not appear on the display, then the previous days data has not been outputed.

Press **CHANGE** + enter a time between 5 seconds and 60 minutes using the red or shite number keys. + ENTER

Press **A U T O** bAud NN will be displayed where "N" is a numeric value.

RECORD

NOTE

The baud rate appears at this time to allow the operator to transfer his data to a computer or peripheral during the measurement process.

Press	**CHANGE**	+	enter 03 for 300 baud	+	**ENTER**
		+	enter 06 for 600 baud	+	
		+	enter 12 for 1200 baud	+	
		+	enter 24 for 2400 baud	+	
		+	enter 48 for 4800 baud	+	
		+	enter 96 for 9600 baud	+	

Press **A U T O** — **no VLF** will be displayed along with the TEST and BATT descriptors

RECORD

Press **A U T O** — **r 000** will be displayed along with the TEST and BATT descriptors.

RECORD

Press **A U T O** — The instrument shuts itself off automatically.

RECORD

Press **MODE** — On the display, all available modes are shown with the present setting flashing.

Press **SPACING** — Until AUTO is flashing.

9

Press **R E A D** — The display will count down from your time interval, display your initial field value and finally the new base reading. At this point, the instrument should shut itself off automatically.

NOTE

To determine whether the base station is functioning properly, the instrument should automatically turn itself on at approximately the time interval you selected, display the previous base reading, the new base reading and shut itself off automatically. Examine the first few reading to ensure that the instrument is functioning properly and the values displayed are correct.

(2) Programming a Base Station Unit

2 b) As an OMNI-PLUS VLF Base Station

On the field and base units:

Press	MODE	On the display, all available modes are shown with the present setting flashing.
Press	SPACING 9	Until TEST is flashing.
Press	R E A D	All modes except TEST will be deleted from the display. The test number 56369.7 will be displayed along with the battery strength indicator (BATT) and the descriptor GAMMA.
Press	TIME DATE 1	A value YY:MM:DD will be displayed along with the TEST, GAMMA and BATT descriptors. Where: YY-year MM-month DD-day
Press	CHANGE +	enter correct time using the red or white number keys.
Press	ENTER	On both units SIMULTANEOUSLY.
Press	OFF	On both units.
Press	R E A D	All modes except TEST will be deleted from the display. The test number 56369.7 will be displayed along with the battery strength indicator (BATT) and the descriptor GAMMA.
Press	TIME DATE 1	On both units SIMULTANEOUSLY. The time on both the field and base unit should be exact. If not repeats the above noted steps.

For the field unit, proceed as outlined in **Programming - Individual Units.**

On the base unit:

At this point, the operator should proceed to the setup location for the base station and assemble the system. This location should be away from any cultural or natural source that may effect the VLF magnetic fields (ie power lines)

NOTE

Prior to entering the operator code, the operator should determine from the field unit what frequencies will be measuring and the time to read each frequency separately. (see Section 3 - How to Take a VLF Reading). The cycling time to use on the base station would be the sum of the time to read up to three VLF frequencies separately plus a minumum of two seconds. This is to ensure that sufficient time is given to read the VLF signals.

Press	**MODE**	On the display, all available modes are shown with the present setting flashing.
Press	**SPACING**	Until TEST is flashing.
	9	
Press	**R A E U A T D O RECORD**	OPNNNN will be displayed along with the TEST and BATT descriptors, where "N" is a numeric value.

NOTE

If OPNNNN does not appear, perform a dumping sequence as described on pages 6 (without being connected to a computer or peripheral).

Press **CHANGE** + **4MNN** for BASE + **ENTER**

where: M= 9 if alkaline batteries are used.
M= 0-8 if rechargeable batteries are used.
N= 0-7 for all three values. These three values are the operator code.

Press **A U T O RECORD** :NN:NN will be displayed along with the INN and TEST descriptors, where "N" is a numeric value.

Press **CHANGE** + enter a time between 5 seconds and 60 minutes using the red or white number keys. + ENTER

Press **A U T O RECORD** bAud NN will be displayed where "N" is a numeric value.

NOTE

The baud rate appears at this time to allow the operator to transfer his data to a computer or peripheral during the measurement process.

Press **CHANGE**

+ enter 03 for 300 baud +
+ enter 06 for 600 baud +
+ enter 12 for 1200 baud +
+ enter 24 for 2400 baud +
+ enter 48 for 4800 baud +
+ enter 96 for 9600 baud +

+ ENTER

Press **A U T O RECORD**

Automatically, IF NN.N will be displayed along with the TEST and BATT descriptors, where "N" is a numeric value. The NN.N will be flashing. The operator has the ability to measure three VLF stations: 1F, 2F and 3F. The frequencies are programmed in kHz with the decimal point fixed. To enter in the frequency:

Press **CHANGE** + the frequency of the station to be measured (ie, 24.0 Cutler). + ENTER

Press **A**
U
T
O

RECORD

For Resistivity Option Only

Automatically, 1rSPNN.N will be displayed, where "N" is a numeric value. This is the electrode spacing for the resistivity option. For base station mode this would be disabled by entering "0".

Press **CHANGE** + 00 + **ENTER**

Press **A**
U
T
O

RECORD

Automatically, 2F NN.N will be displayed along with the TEST and BATT descriptors, where "N" is a numeric value. The NN.N will be flashing. To enter in the frequency:

Press **CHANGE** + the frequency of the station to be measured (ie, 248 Seattle). + **ENTER**

Press **A**
U
T
O

RECORD

For Reseetivity Option Only

If a frequency other than 0.0 is selected, then 2rSPNN.N will be displayed where "N" is a numeric value.

Press **CHANGE** + 00 + **ENTER**

Press **A U T O**

RECORD

Automatically, 3F NN.N will be displayed along with the TEST and BATT descriptors. To enter in the frequency:

Press **CHANGE** + the frequency of the station + **ENTER** to be measured.

For Resistivity Option Only

If a frequency other than 00.0 is selected, then 3rSP NN.N will be displayed, where "N" is a numeric value.

Press **CHANGE** + 00 + **ENTER**

NOTE

If only two VLF stations are to be measured, enter 00.0 for the third frequency. If only one VLF station is to be measured, enter 00.0 for the second and third frequencies.

Press **A U T O** **init** will be displayed along with the TEST and BATT descriptors.

RECORD

The system is now calibrating the VLF coils. This process takes between approcimately 45 seconds. During this initialization process where "init" is displayed, the system is automatically setting the gain settings for the VLF frequencies selected. When the calibration is completed, 1 NNNN will be shown on the display, where "NNNN" is the calibrated field value for the first frequency. If the audio alarm is activated during the initialization process, press the VLF key.

Using the VLF key:

The values expected are as follows:

FIELD	200-400	Induced calibration field strength.
PHASE	70.7+/- 3%	Checking the electronic matching of the channels. A malfunctioning channel will be indicated by a value outside of the allowable value.

If the values are satisfactory:

Press	**TIEBASE** (twice) - **SPOT** **RECORD**	The calibration values are now stored. It would be a good policy to store the calibration readings at the start of each day or any time during the day when an initialization process is performed.
Press	**MODE**	On the display, all available modes are shown with the present selling flashing.
Press	SPACING 9	Until VLF AUTO is flashing.
Press	**R** **E** **A** **D**	This display will count down from your time interval, display the test calibrated field value and finally the new base VLF total field reading. At this point, the instrument should shut itself off automatically.

NOTE

To determine whether the base station is functioning properly, the instrument should automatically turn itself on at approximately the time interval you selected, display the previous base VLF total field reading, the new base VLF total field reading and shut itself off automatically. Examine the first few readings to ensure that the instrument is functioning properly and the values displayed are correct.

(2) Programming a Base Station Unit

2 b) As an Combined OMNI-PLUS Magnetometer/VLF Base Station

On the field and base units:

Press	**MODE**	On the display, all available modes are shown with the present setting flashing.
Press	**SPACING** **9**	Until TEST is flashing.
Press	**R** **E** **A** **D**	All modes except TEST will be deleted from the display. The test number 56369.7 will be displayed along with the battery strength indicator (BATT) and the descriptor GAMMA.
Press	**TIME** **DATE** **1**	A value YY:MM:DD will be displayed along with the TEST, GAMMA and BATT descriptors. Where: YY-year MM-month DD-day
Press	**CHANGE** +	enter correct time using the red or white number keys.
Press	**ENTER**	On both units **SIMULTANEOUSLY.**
Press	**OFF**	On both units.
Press	**R** **E** **A** **D**	All modes except TEST will be deleted from the display. The test number 56369.7 will be displayed along with the battery strength indicator (BATT) and the descriptor GAMMA.
Press	**TIME** **DATE** **1**	On both units **SIMULTANEOUSLY.** The time on both the field and base unit should be exact. If not repeats the above noted steps.

For the field unit, proceed as outlined in **Programming - Individual Units.**

On the base unit:

At this point, the operator should proceed to the setup location for the base station and assemble the system. This location should be away from any cultural or natural source that may effect the magnetic or VLF fields (ie power lines)

NOTE

Prior to entering the operator code, the operator should determine from the field unit what frequencies will be measuring and the time to read each frequency separately. (see Section 3 - How to Take a VLF Reading). The cycling time to use on the base station would be the sum of the time to read up to three VLF frequencies separately plus a minumum of two seconds. This is to ensure that sufficient time is given to read the VLF signals.

Press	**MODE**	On the display, all available modes are shown with the present setting flashing.
Press	**SPACING**	Until TEST is flashing.
	9	
Press	**R A E U A T D O RECORD**	**OPNNNN** will be displayed along with the TEST and BATT descriptors, where "N" is a numeric value.

NOTE

If OPNNNN does not appear, perform a dumping sequence as described on pages 6 (without being connected to a computer or peripheral).

Press **CHANGE** + **4MNN for BASE** + **ENTER**

where: M= 9 if alkaline batteries are used.
M= 0-8 if rechargeable batteries are used.
N= 0-7 for all three values. These three values are the operator code.

Press	A U T O RECORD	:NN:NN will be displayed along with the INN and TEST descriptors, where "N" is a numeric value.
Press	CHANGE +	enter a time between 5 seconds and 60 minutes using the red or shite number keys. + ENTER
Press	A U T O RECORD	bAud NN will be displayed where "N" is a numeric value.

NOTE

The baud rate appears at this time to allow the operator to transfer his data to a computer or peripheral during the measurement process.

Press	CHANGE +	enter 03 for 300 baud + ENTER
	+	enter 06 for 600 baud +
	+	enter 12 for 1200 baud +
	+	enter 24 for 2400 baud +
	+	enter 48 for 4800 baud +
	+	enter 96 for 9600 baud +
Press	A U T O RECORD	

Automatically, IF NN.N will be displayed along with the TEST and BATT descriptors, where "N" is a numeric value. The NN.N will be flashing. The operator has the ability to measure three VLF stations: 1F, 2F and 3F. The frequencies are programmed in kHz with the decimal point fixed. To enter in the frequency:

Press	CHANGE +	the frequency of the station to be measured (ie, 24.0 Cutler). + ENTER

Press **A**
U
T
O

RECORD

For Resistivity Option Only

Automatically, lrSPNN.N will be displayed, where "N" is a numeric value. This is the elctrode spacing for the resistivity option. For base station mode this would be disabled by entering "0".

Press **CHANGE** + 00 + **ENTER**

Press **A**
U
T
O

RECORD

Automatically, 2F NN.N will be displayed along with the TEST and BATT descriptors, where "N" is a numeric value. The NN.N will be flashing. To enter in the frequency:

Press **CHANGE** + the frequency of the station to be measured (ie, 248 Seattle). + **ENTER**

Press **A**
U
T
O

RECORD

For Resestivity Option Only

If a frequency other than 0.0 is selected, then 2rSPNN.N will be displayed where "N" is a numeric value.

Press **CHANGE** + 00 + **ENTER**

Press **A U T O**

RECORD

Automatically, 3F NN.N will be displayed along with the TEST and BATT descriptors. To enter in the frequency:

Press **CHANGE** + the frequency of the station + **ENTER** to be measured.

For Resistivity Option Only

If a frequency other than 00.0 is selected, then 3rSP NN.N will be displayed, where "N" is a numeric value.

Press **CHANGE** + 00 + **ENTER**

NOTE

If only two VLF stations are to be measured, enter 00.0 for the third frequency. If only one VLF station is to be measured, enter 00.0 for the second and third frequencies.

Press **A U T O** **init** will be displayed along with the TEST and BATT descriptors.

RECORD

The system is now calibrating the VLF coils. This process takes between approcimately 45 seconds. During this initialization process where "init" is displayed, the system is automatically setting the gain settings for the VLF frequencies selected. When the calibration is completed, 1 NNNN will be shown on the display, where "NNNN" is the calibrated field value for the first frequency. If the audio alarm is activated during the initialization process, press the VLF key.

Using the VLF key:

The values expected are as follows:

FIELD	200-400	Induced calibration field strength.
PHASE	70.7+/- 3%	Checking the electronic matching of the channels. A malfunctioning channel will be indicated by a value outside of the allowable value.

If the values are satisfactory:

Press	TIEBASE (twice) - SPOT RECORD	The calibration values are now stored. It would be a good policy to store the calibration readings at the start of each day or any time during the day when an initialization process is performed.
Press	MODE	On the display, all available modes are shown with the present selling flashing.
Press	SPACING 9	Until AUTO is flashing.
Press	R E A D	This display will count down from your time interval, display the test calibrated field value and finally the new base VLF total field reading. At this point, the instrument should shut itself off automatically.

NOTE

To determine whether the base station is functioning properly, the instrument should automatically turn itself on at approximately the time interval you selected, display the previous base VLF total field reading, the new base VLF total field reading and shut itself off automatically. Examine the first few readings to ensure that the instrument is functioning properly and the values displayed are correct.

(3) Initializing The Field Unit

At this point, the operator should assemble the instrument and proceed to the site. The VLF sensor coils require to be calibrated and this should be performed away from any sources that may affect the coils (ie, video displays) and in the same direction of the lines being surveyed.

Press	MODE	The mode that the unit should be set to TEST. Again, the mode setting is flashing. If the unit is not set to TEST, change mode as described in the programming section.
Press	R E A D / A U T O	3000 OPNNNN will be displayed along with the TEST and BATT descriptors, where "N" is a numeric value.

RECORD

NOTE

If OPNNNN does not appear, perform a dumping sequence as described on pages 6-9, 10 (without being connected to a computer or peripheral).

Press CHANGE + 3MNN for TFM + ENTER
+ 4MNN for BASE +
+ 5MNN for GRAD +

where: M= 9 if alkaline batteries are used.
M= 0-8 if rechargeable batteries are used.
N= 0-7 for all three values. These three values are the operator code.

(3) Initializing The Field Unit (con't)

Note: **1)** Once the new operator code has been entered, recovery of the data stored prior to entry of the new code will **NOT BE POSSIBLE THROUGH THE DUMP MODES.**

2) For VLF only, it is suggested that 3MNN be used for field surveys and 4MNN for base station operation.

Press **A**
U
T
O

RECORD

Automatically, 1F NN.N will be displayed along with the VLF, TEST and BATT descriptors, where "N" is a numeric value. The NN.N will be flashing. The operator has the ability to measure three VLF stations: 1F, 2F and 3F. The frequencies are programmed in kHz with the decimal point fixed. To enter in the frequency:

Press CHANGE + the frequency of the station + ENTER to be measured (ie, 24.0 Cutler).

Press **A**
U
T
O

RECORD

For Resistivity Option Only

Automatically, 1rSPNN.N will be displayed, where "N" is a numeric value. This is the electrode spacing for the resistivity option. A spacing of 5, 10 or 20 may be entered. If "0" is entered, then the resistivity (VLF electric) measurements are disabled. To enter the spacing:

(3) Initializing The Field Unit (con't)

Press **CHANGE** + 5, 10 or 20 + **ENTER**

Press **A**
U
T
O

RECORD

Automatically, 2F 00.0 will be displayed along with the VLF, TEST and BATT descriptors. To enter in the frequency of this station:

Press **CHANGE** + the frequency of the station + **ENTER**
to be measured (ie, 24.8 Seattle)

Press **A**
U
T
O

RECORD

For Resistivity Option Only

If a frequency other than 00.0 is selected then 2rSPNN.N will be displayed where "N" is a numeric value. If a resistivity/VLF electric/measurement is required:

Press **CHANGE** + 5, 10 or 20 + **ENTER**

Press **A**
U
T
O

RECORD

Automatically, 3F 00.0 will be displayed along with the VLF, TEST and BATT descriptors. To enter in the frequency of this station:

Press **CHANGE** + the frequency of the station + **ENTER**
to be measured.

(3) Initializing The Field Unit (con't)

For Resistivity Option Only

If a frequency other than 00.0 is selected, then 3rSPNN.N will be displayed, where "N" is a numeric value. If a resistivity (VLF electric) measurement is required.

Note: If only two VLF stations are to be measured, enter 00.0 for the third frequency. If only one VLF station is to be measured, enter 00.0 for the second and third frequencies.

0017

Press **A** **U** **T** **O** **P NNNN** will be displayed where "N" is a numeric value.

RECORD

NOTE

As described earlier, the OMNI-PLUS corrects the VLF readings for line direction. Enter either a positive or negative position spacing that corresponds to the direction you will be travelling.

Press **CHANGE** + positive or negative position spacing. + **ENTER**

At this point, stand still, face the direction you will be performing the survey and:

Press **A** **U** **T** **O**

RECORD

The system is now calibrating the VLF coils. This process takes approximately 30 seconds and during this period the operator should stand still and do not press any of the keys (unless the audio alarm is activated. At this time, press the VLF key). During this initialization process, "init" is displayed and the system is automatically setting the gain settings for the VLF frequencies selected. When the calibration is completed, 1 NNNN will be shown on the display, where "NNNN" is the calibrated field value for the first frequency.

The values expected are as follows:

FIELD	2000-4000	Induced calibration field strength.
PHASE	70.7 +/- 3%	Checking the electronic matching of the channels. A malfunctioning channel will be indicated by a value outside of the allowable value.
QUAD	01 or 02	Mode setting (see Section 9).
TILT	01 to 17	Gain setting (see Section 9).

Press	**TIEBASE** (twice) – **SPOT** **RECORD**	The calibration values are now stored. It would be a good policy to store the calibration readings at the start of each day or any time during the day when an initialization process is performed.

At this time, the operator should determine whether a satisfactory signal is being received from the VLF stations.

NOTE

During the course of the day, the operator may re-calibrate the VLF system or change the VLF frequencies. This may be performed if the the total field intensity of the frequency changes dramatically or after a prolonged shutdown period.

(3) Initializing The Field Unit (con't)

Press	MODE	
Press	SPACING 9	Select the TFM for a magnetometer total field survey or GRAD for a gradient survey or VLF for a VLF survey only.
Press	R E A D	The unit will display the parameter (magnetometer of VLF) which was last viewed on the previous reading when the VLF and magnetometer signals have been measured, the new value of the last parameter viewed will be displayed.
Press	FREQ. SELECT	
Press	VLF	Until the total field intensity is displayed. If the value is greater than 2.0 then the values are above the background noise level. The validity of the data is to the descretion of the user.

NOTE

At this point, the operator should perform a couple of readings in the same direction to determine the repeatibility of the data. Also, several measurements in the opposite direction (ie, 180 degrees) should be performed. The in-phase and quadrature readings should be within one percent of the readings performed in the opposite direction, except that the readings will have an opposite sign (ie positive or negative). If there is a large (± 5%) discrepancy in the values obtained, please contact an EDA representative immediately.

(3) Initializing The Field Unit (con't)

Noted below are some gain settings and measured total field strengths (not calibrated field strengths) for various stations and reading locations. Gain settings range from 1 for excellent to 15 for poor:

Station	Location	Gain Setting	Total Field
15.1			
	Europe		
	Northern Ireland		30
	North America		
	Caribou, Nova Scotia	15	2
	Bathurst, New Brunswick	13	3
	Springdale, NFLD	13	3
	Madoc, Ontario	15	1

Station	Location	Gain Setting	Total Field
16.0			
	Europe		
	Northern Ireland		20
	Beauvais, France	9	35
	Hull, England	6	140
	Thessaloniki, Greece	13	8
	Prague, Czechoslovakia	10	30
	Africa		
	Bamako, Mali		2
	North America		
	Bathurst, New Brunswick		2
	Springdale, NFLD	14	3

Station	Location	Gain Setting	Total Field
16.4			
	Europe		
	Northern Ireland		7
	Hull, England	11	10
	Thessaloniki, Greece	13	4
	Beauvais, France	14	6
	North America		
	Bathurst, New Brunswick		1

Station	Location	Gain Setting	Total Field
16.8			
	Europe		
	Prague, Czechoslovakia		25
	Hull, England		4
	Thessaloniki, Greece		8
	Northern Ireland		7
	Beauvais, France	8	50

Station	Location	Gain Setting	Total Field
17.4			
	North America		
	Vancouver, British Columbia	15	1
	Asia		
	Seoul, Korea	9	20

Station Location	Gain Setting	Total Field
19.0		
Europe		
Northern Ireland		80
Hull, England	5	110
Thessaloniki, Greece	10	12
Prague, Czechoslovakia		35
Beauvais, France	7	40
North America		
Caribou, Nova Scotia	14	3
Bathurst, New Brunswick	13	4
Springdale, NFLD	13	4

Station	Location	Gain Setting	Total Field
19.6			
	Europe		
	Hull, England	7	80
	Prague, Czechoslovakia		30
	Thessaloniki, Greece		6
	Beauvais, France		25

Station	Location	Gain Setting	Total Field
21.4			
	Europe		
	Northern Ireland		5
	Beauvais, France	14	3
	North America		
	Calgary, Alberta		10
	Deer Lake, NFLD	9	17
	Edmonton, Alberta		8
	Madoc, Ont.	10	13
	Revelstoke, B.C.	12	5
	Vancouver, B.C.	10	9
	Whitehorse, Yukon	13	4
	Bathurst, New Brunswick	7	40
	Africa		
	Bamako, Mali		5

Station	Location	Gain Setting	Total Field
22.3			
	North America		
	Vancouver, British Columbia	13	3
	Asia		
	Seoul, S. Korea	10	10
	Australia		
	Canberra, N.S.W.	8	22
	Fremantle, W.A.	5	110

Station	Location	Gain Setting	Total Field
23.4 (Hawaii)			
	North America		
	Calgary, Alberta		5
	Revelstoke, B.C.	11	8
	Vancouver, B.C.		15
	Whitehorse, Yukon	11	8
	Winnipeg, Manitoba	15	6
	Australia		
	Canberra, N.S.W.	13	3

Station Location	Gain Setting	Total Field
23.4 (West Germany)		
Europe		
Northern Ireland		20
Beauvais, France	7	32
Keil, West Germany	3	350
Hull, England	5	95
Thessaloniki, Greece	8	25
Prague, Czechoslovakia	5	115
North America		
Caribou, Nova Scotia	12	2
Bathurst, New Brunswick		5
Springdale, NFLD	13	3
Africa		
Bamako, Mali		7

Station	Location	Gain Setting	Total Field
24.0			
	Europe		
	Northern Ireland		14
	Beauvais, France	11	6
	Hull, England	9	13
	Thessaloniki, Greece	14	3
	Prague, Czechoslovakia		3
	Africa		
	Bamako, Mali		7
	North America		
	Calgary, Alberta		8
	Deer Lake, NFLD	7	45
	Edmonton, Alberta		6
	Madoc, Ont.	3	50
	Revelstoke, B.C.	12	4
	Vancouver, B.C.	13	3
	Whitehorse, Yukon	13	5
	Caribou, Nova Scotia	2	300
	Bathurst, New Brunswick	3	150

Station	Location	Gain Setting	Total Field
24.8			
	North America		
	Calgary, Alberta		35
	Edmonton, Alberta		60
	Madoc, Ontario	10	8
	Revelstoke, B.C.	3	140
	Vancouver, B.C.	2	450
	Whitehorse, Yukon	9	14
	Caribou, Nova Scotia	14	2
	Bathurst, New Brunswick	12	4
	Springdale, NFLD	15	1
	Asia		
	Seoul, S. Korea	15	3

Station	Location	Gain Setting	Total Field
28.5			
	Europe		
	Northern Ireland		3
	North America		
	Deer Lake, NFLD	12	4
	Bathurst, New Brunswick	15	1
	Toronto, Ontario	15	2
	Winnipeg, Manitoba	15	2

(4) Starting The Field Survey

Press	MODE	All the mode settings will be displayed with the present setting flashing.
Press	SPACING 9	Until the required survey setting is flashing (ie, TFM for a magnetometer total field survey and VLF survey; GRAD for a gradiometer and VLF survey; VLF for a VLF survey only).
Press	R E A D	The unit will display the previous reading and automatically measure and display either the magnetometer total field or one of the VLF parameters.
Press	MULTI RECORD	The initial position (station) number programmed will be displayed Along with the position value, the BATT and mode setting (ie, GRAD) will be displayed.

NOTE

While the magnetometer total field is being displayed, the BATT, SENSOR and DECAY descriptors allow the opertor to visually determine the battery strength and quality of the magnetometer total field reading.

When the VLF parameters are being displayed, the second and third set of descriptor bars are being used to monitor the operator quality and signal/noise ratio of up to three VLF frequencies.

The readings cannot be stored until the VLF signals have been measured. If the any of the RECORD keys are pressed prior to completion, "wait" will be displayed.

If the readings are satisfactory and the position value is correct:

Press	MULTI RECORD	The reading is correctly stored if the unit shuts off automatically.

(4) Starting The Field Survey (con't)

After proceeding to the next station:

Press	**R** **E** **A** **D**	The unit will display the parameter (magnetometer or VLF) which was last viewed on the previous reading. When the VLF and magnetometer signals have been measured, the new value of the last parameter viewed will be displayed.
Press	**A** **U** **T** **O**	The position number will be updated automatically and displayed on the LCD.
	RECORD	

If the position and readings are satisfactory:

Press	**A** **U** **T** **O**	The data is stored and the unit shuts off automatically.
	RECORD	

WHEN CHANGING LINES:

Press	**R** **E** **A** **D**	The unit will display the parameter (magnetometer or VLF) which was last viewed on the previous reading. When the VLF and magnetometer signals value of the last parameter viewed will be displayed.

(4) Starting The Field Survey (con't)

Press	**LINE**	**UPDATE**	The line value will be updated and displayed automatically depending on the line spacing programmed into memory.
	7	**0**	
Press	**POS**	**SPACING**	The position spacing will be displayed along with the INTV descriptor.
	8	**9**	
Press	**CHANGE**	**CLEAR**	**ENTER** The sign (ie, +/-) will switch depending on the previous setting.
		+	
		-	
Press	**MULTI**		The position value will be the same as that of the previous line, but the line has been updated.
	RECORD		
Press	**MULTI**		The data is stored and the unit shuts off automatically.
	RECORD		

After proceeding to the next station:

Press	**R** **E** **A** **D**	The unit will display the parameter (magnetometer or VLF) which was last viewed on the previous reading have been measured, the new value of the last parameter viewed will be displayed.
Press	**A** **U** **T** **O**	The position (station) will be automatically updated and displayed on the LCD.
	RECORD	

(4) Starting The Field Survey (con't)

Press	**A** **U** **T** **O**	The data is stored and the unit shuts off automatically.
	RECORD	

At this point, you may complete your survey noting the following points:

a)	**A** **U** **T** **O**	Automatically updates the position.
	RECORD	
b)	**MULTI**	Use when taking additional readings at one location (station), when changing lines or starting the survey.
	RECORD	
c)	**TIEBASE**	For taking random readings where the data is stored under a record number (ie, r0001).
	SPOT RECORD	

NOTE

Any of the above record keys must be pressed twice sequentially to store the data in memory.

SECTION 6

DATA RETRIEVAL

6.1 MODE SETTINGS

The data stored may be dumped through four access modes, depending on which data the operator wishes to view. The four access modes are:

i) DUMP — This mode allows the operator to access the magnetometer and gradient data in a format noted in Figure 6-1. Through this mode, the data may be outputted uncorrected (ie, no corrections for diurnal variations of the earth's magnetic field), or corrected either through a base station or the built-in tie-line memory.

ii) PROG — This mode allows the operator to transfer the magnetometer and gradient data to a computer or peripheral in an ASCII Fixed Format CPU dump as noted in Figure 6-2.
Also, through this mode , the magnetometer total field and gradient data may be outputted in profile plots.

iii) VLF DUMP — This mode allows the operator to access the VLF data in a format noted in Figure 6-3. Through this mode, the VLF total field data can be outputted uncorrected (i.e. no corrections for variations in the primary field) or corrected either through a base station or the built in tie-line memory.

iv) VLF PROG — This mode allows the operator to transfer the VLF data to a computer or peripheral in an ASCII Fixed Format CPU dump as noted in Figure 6-4.
Also, through this mode, the analog output for the VLF total field, vertical in-phase and vertical quadrature may be outputted in profile plots.

NOTE

ASCII formatted data has been provided to allow the user to easily interface with computer plotting or analysis software. Also, the ASCII data provides the user with invaluable information on the proper performance of the system.

Data Retrieval (con't)

```
OMNI-PLUS  Tie-line MAG/VLF R22B  Ser  #28107
TOTAL FIELD DATA (uncorrected)
& GRADIENT

Reference  field: 00000.0
Datum subtracted:      0.0Date 21 MAY 88
Operator:  5000
Records:  18
Bat:  17.3 Volt     Lithium:  3.48 Volt
Last time update:  5/21 11:17:00
Start  of  print:  5/21 16:14:52


Line  0+00 N  Date 21 MAY 88            #1
POSITION   FIELD  ERR    DRIFT    TIME    DS CULT   GRADIENT
    #1    56369.7 .00       0.0 12:08:49 88

Line  1+00 S  Date 21 MAY 88          #2
POSITION   FIELD  ERR    DRIFT    TIME    DS CULT   GRADIENT
  0+00 E 46007.3 .10       0.0 14:23:17 88              2.1
  0+25 E 46008.5 .10       0.0 14:25:39 88              3.7
  0+50 E 46009.4 .10       0.0 14:26:43 88              4.7
  0+75 E 46008.2 .08       0.0 14:27:46 88 Road         8.8
  1+00 E 46010.0 .10       0.0 14:28:50 88              4.7
  1+25 E 46009.6 .09       0.0 14:29:39 88              2.0
  1+50 E 46009.8 .09       0.0 14:30:19 88              2.9
  1+75 E 46010.0 .08       0.0 14:31:01 88              4.7
  2+00 E 46010.0 .09       0.0 14:31:39 88              3.3
  2+25 E 46009.8 .09       0.0 14:32:24 88              2.6
  2+50 E 46010.1 .10       0.0 14:33:04 88              3.7
  2+75 E 46010.9 .09       0.0 14:33:48 88              2.5
  3+00 E 46010.8 .09       0.0 14:34:30 88              2.4
  3+25 E 46010.7 .11       0.0 14:35:20 88              2.1
  3+50 E 46010.6 .08       0.0 14:36:02 88              3.9
  3+75 E 46010.6 .08       0.0 14:36:48 88              4.6
  4+00 E 46011.1 .08       0.0 14:37:39 88              6.3

EOF
```

Figure 6-1
Magnetometer Dump Format

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Data Retrieval (con't)

```
HU 502177770022    3350021300016503 42
H1      -0     -0 563697000000
H2  10111490008261539590827085854
H3                                0
H4

D   826155235 574828     8        0   5000    1000     588 574869
D   826155620 575004     9        0   5000    1500     688 575009
D   826155910 576004    10        0   5000    2000     688 576073
D   826160224 575412    11        0   5000    2500     688 575460ROAD
D   826160537 575107    12        0   5000    3000     688 574940
D   826160751 575187    13        0   5000    3500     588 575237 50
D   826163419 575454    14        0   5000    4000     688 575448 50
D   826163555 575367    15        0   5000    4500     588 575369 50
D   826163851 576935    16        0   5000    5000     688 577153
D   826164646 576263    17        0   2000    3000     688 576255 50
D   826165023 576065    18        0   2000    2500     688 576047
D   826165220 575559    19        0   2000    2000     588 575568
D   826165433 575583    20        0   2000    1500     588 575592
D   826165623 574884    21        0   2000    1000     588 574860
D   826165704 574888    22        0   2000    1000     588 574866 50
D   826165905 574249    23        0   2000     500     588 574181 50

EOF
```

Figure 6-2
Magnetometer ASCII Fixed Format CPU Dump

Data Retrieval (con't)

```
OMNI-PLUS  Tie-line MAG/VLF V12G  Ser  #17???
VLF TOTAL FIELD DATA (uncorrected)
Date 29 JUL 88
Operator:  3002
Records:   24
Bat:  17.9 Volt    Lithium:  3.48 Volt
Last time update:  7/13  7:30:00
Start  of  print:  7/29 12:18:11
```

Line 0+00 E Date 29 JUL 88 24.0 #1

POSITION	I/P	QUAD	T.FLD	TILT	TIME	CULT S	DIR	4-FRA	5-FRA
#1	71.4	0.1	3656.	6.0	10:36:26	99	0.0	!	

Line 10+00 E Date 29 JUL 88 24.0 #2

POSITION	I/P	QUAD	T.FLD	TILT	TIME	CULT S	DIR	4-FRA	5-FRA
20+00 N	-2.1	1.6	54.97	-1.2	10:37:35	45	21.9		
20+125N	-2.2	1.2	54.01	-1.2	10:37:43	36	20.4		
20+25 N	-2.6	1.4	54.34	-1.5	10:37:48	36	20.8		
20+375N	-2.1	1.3	54.10	-1.2	10:37:53	45	21.0	0.3	
20+50 N	-2.6	1.1	53.54	-1.4	10:37:59	53	19.1	-0.1	0.1
20+625N	-2.4	1.1	53.80	-1.4	10:38:05	63	20.2	0.1	0.0
20+75 N	-2.5	1.3	54.14	-1.4	10:38:11	63	20.1	0.2	0.1
20+875N	-2.4	1.1	53.88	-1.4	10:38:16	64	20.3	0.0	0.1
21+00 N	-2.3	1.3	53.20	-1.3	10:38:21	63	20.4	-0.1	-0.1
21+125N	-2.1	1.1	53.30	-1.2	10:38:28	63	18.8	-0.3	-0.2
21+25 N	-2.4	1.3	54.10	-1.3	10:38:34	64	20.9	-0.2	-0.3
21+375N	-2.3	1.1	53.37	-1.3	10:38:39	64	18.2	0.1	-0.1
21+50 N	-2.1	1.1	53.85	-1.2	10:38:48	54	21.5	0.0	0.0
21+625N	-2.2	1.2	53.24	-1.3	10:39:16	54	18.1	-0.1	-0.1
21+75 N	-2.3	1.3	53.65	-1.3	10:39:21	54	18.9	0.1	0.0
21+875N	-2.0	1.6	53.37	-1.1	10:39:26	54	18.5	-0.1	0.0
22+00 N	-1.9	1.4	53.72	-1.1	10:39:31	54	18.6	-0.4	-0.3
22+125N	-2.1	0.8	53.84	-1.2	10:39:36	54	18.2	-0.1	-0.3
22+25 N	-2.3	1.0	53.65	-1.3	10:39:41	64	18.4	0.3	0.1
22+375N	-1.6	1.2	53.99	-0.9	10:43:58	34	23.3	-0.1	0.1
22+50 N	-1.4	1.2	53.52	-0.8	10:44:09	54	21.7	-0.8	-0.5
22+625N	-1.9	1.4	53.87	-1.1	10:44:18	55	23.0	-0.3	-0.6
22+75 N	-1.5	1.2	53.88	-0.8	10:44:23	54	20.3	0.2	-0.1

EOF

Figure 6-3
VLF Dump Format

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Data Retrieval (con't)

```
OMNI-PLUS  Tie-line MAG/VLF ROOF  Ser  #20002
VLF TOTAL FIELD DATA (Tieline corrected)
Date 29 JUN 88
Operator:  3002
Records:   17
Bat:  16.7 Volt     Lithium:  3.48 Volt
Last time update:  1/01  9:10:00
Start  of  print:  6/29 17:20:47


Line  0+00 N  Date 29 JUN 88  24.0     #1
POSITION     I/P   QUAD T.FLD  TILT    TIME    CULT %  DIR  4-FRA T-COR RESIS PHA
    #1       70.5   0.2 3678.   5.0 16:53:13      99   0.0 !          0

Ref. Fld    -4.9  -1.2 77.37   -2.8 16:53:44      49 -58.8 !      100.0

Pos   0+00 E  Date 29 JUN 88  24.0     #3
Tie-Line     I/P   QUAD T.FLD  TILT    TIME    CULT %  DIR  4-FRA T-COR RESIS PHA
  1+00TN    -4.9  -1.3 78.41   -2.7 16:53:57      49 -59.0          101.6
  2+00TN    -4.7  -1.5 74.33   -2.7 16:54:11      49 -59.6           96.7

Ref. Fld    -4.6  -2.5 76.69   -2.6 16:54:19      49 -56.5 !      100.0

Line  1+00 N  Date 29 JUN 88  24.0     #4
POSITION     I/P   QUAD T.FLD  TILT    TIME    CULT %  DIR  4-FRA T-COR RESIS PHA
  0+00TE    -5.2  -1.3 78.80   -2.9 16:54:29      49 -57.9          101.6
  0+10 E    -4.8  -1.5 74.13   -2.3 16:54:50      49 -59.2           95.9
  0+20 E    -4.6  -2.1 74.17   -2.6 16:54:59      49 -59.2           97.0
  0+30 E    -5.3  -2.0 73.12   -3.0 16:55:06      39 -56.8   0.5     94.8
  0+40 E    -5.1  -2.3 74.26   -2.9 16:55:13      49 -59.2   1.0     94.4
  0+50 E    -4.4  -1.0 76.54   -2.5 16:55:22B08   49 -58.3  -0.2     95.5

Line  2+00 N  Date 29 JUN 88  24.0    #12
POSITION     I/P   QUAD T.FLD  TILT    TIME    CULT %  DIR  4-FRA T-COR RESIS PHA
  0+50 E    -7.2  -1.7 74.71   -4.1 16:55:43      74 -53.2          97.4
  0+40 E    -6.8  -2.7 74.79   -3.9 16:56:10      74 -53.7          97.9
  0+30 E    -6.7  -2.7 74.78   -3.9 16:56:17ROAD  74 -54.2          97.9
  0+20 E    -7.0  -1.5 74.73   -4.0 16:56:24      74 -53.4   0.2    98.1
  0+10 E    -6.5  -2.0 75.20   -3.7 16:56:32      74 -52.9   0.0    98.8
  0+00TE    -6.2  -2.8 73.49   -3.5 16:56:40      74 -53.1   0.6    96.7
```

Figure 6-4
VLF Dump Format
(with Resistivity Option)

Data Retrieval (con't)

```
H0 300290029900     1730020300001670348
H1       -0      -0 56900000000
H2  10109100006291653210629170205
H3                              0
H4
H5  F2 R22F

I-   629165213 563697     1        0       0       0       88       0
V1 240   705      2 347800     50 99       0  120       0       0       0       0
V2 214   694      2 346700     20 99       0  120       0       0       0       0
I-1  629165344 563697     2  561697  99992  99990 300328       0
V1 240   -49    -12   7707   -20 49  -588  120    7737       0       0       0
V2 214  -419      9  31320  -227 49  -705  120   31320       0       0       0
I-2  629165357 563697     3  563697   1000       0       28       0
V1 240   -48    -13   7041   -27 49  -590   20    7713       0       0       0
V2 214  -417     11  32262  -224 39  -702   20   30712       0       0       0
I-2  629165401 563697     4  563697   2002       0       28       0
V1 240   -47    -15   7433   -27 49  -594   20    7685       0       0       0
V2 214  -421     12  30782  -228 49  -705   20   30002       0       0       0
I-1  629165413 563697     5  563697  99992  99990       28       0
V1 240   -46    -15   7445   -26 49  -595  120    7669       0       0       0
V2 214  -420     13  29622  -221 49  -704  120   29602       0       0       0
I-   629165428 563697     6  563697   1000       0       28       0
V1 240   -52    -13   7390   -29 49  -579   20    7751       0       0       0
V2 214  -421      7  29050  -228 39  -703   20   27650       0       0       0
I-   629165450 563697     7  563697   1300     100       28       0
V1 240   -49    -15   7413   -23 49  -592   20    7724       0       0       0
V2 214  -421      9  28073  -229 39  -701   20   28192       0       0       0
I-   629165459 563697     8  563697   1002     200       28       0
V1 240   -44    -21   7437   -26 49  -590   20    7717       0       0       0
V2 214  -423      8  26800  -229 49  -705   20   29990       0       0       0
I-   629165506 563697     9  563697   1300     300       28       0
V1 240   -53    -20   7012   -30 39  -599   20    7707       0       0       0
V2 214  -412      8  29470  -224 49  -713   20   28500       0       0       0
```

Figure 6-5
VLF ASCII Fixed Format CPU Dump

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Data Retrieval (con't)

```
H0 3002000200022     1430221300216600340
H1       -0      -2 5630000020002
H2  7040637000707231146070723255 2
H3                                0
H4
H5  F2 R22F

I:    707231135 563697      1          0       0       0      88       0
V1 248   710      1 378900    100 99     0  110     0  14410    173       0
I:    707231224 563697      2          0       0       0      29       0
V1 248   -24    -10   1130    -14 87   148  110     0   4944    207      19
I:    707231250 563697      3          0       0       0      29       0
V1 248   -19    -19   1110    -11 85   147  110     0   4922    212      19
I:    707231322 563697      4          0       0       0      28       0
V1 248   -20     17   1110     25 78   153  110     0   4964    213      17
I:    707231803 563697      5          0       0       0      29       0
V1 248   -21    -21   1112    -12 87   163  110     0   4337    217      21
I:    707231420 563697      6          0       0       0      28       0
V1 248   -22    -23   1110    -11 87   165  110     0   4637    230      23
I:    707231845 563697      7          0       0       0      29       0
V1 248   -22    -21   1110    -17 84   164  110     0   4542    222      21
I:    707231859 563697      8          0       0       0      29       0
V1 248   -24    -14   1101    -14 86   162  110     0   4397    225      14
I:    707231910 563697      9          0       0       0      29       0
V1 248   -25    -11   1111    -14 16   166  110     0   4615    230      12
I:    707231927 563697     10          0       0       0      29       0
V1 248   -21    -24   1111     12 87   162  110     0   4513    228      24
I:    707231941 563697     11          0       0       0      27       0
V1 248   -26    -19   1110    -14 87   163  110     0   4642    216      19
I:    707231955 563697     12          0       0       0      29       0
V1 248   -22    -15   1114    -12 86   161  110     0   4502    214      15
I:    707232 10 563697     13          0       0       0      29       0
V1 248   -17    -19   1110    -10 87   162  110     0   4649    220      19
I:    707232025 563697     14          0       0       0      29       0
V1 248   -22    -22   1112    -12 87   163  110     0   5402    219      22

EOF
```

Figure 6-5
VLP ASCII Fixed Format CPU Dump
(with Resistivity Option)

Data Retrieval (con't)

6.2 BAUD RATE

An added feature of the OMNI-PLUS is the ability to transfer the data using various baud rate settings. During the dumping process, the operator will be asked to set the baud rate. The OMNI-PLUS uses hardware handshaking at 8 data bits, 2 stop bits and no parity. The available baud rate settings are as follows:

300 Baud
600 Baud
1200 Baud
2400 Baud
4800 Baud
9600 Baud

6.3 ACCESS CODE

Through the access codes, the operator has the ability to transfer the data in various formats. This access code is noted by the designation HP0000 in the dumping procedure. The composition of the code is as follows:

0000

The first digit designates the type of data to be retrieved. This designation applies to both the magnetic and VLF data. The possibilities are as follows:

1 = Raw data dump. The contents in the memory are dumped to the recording device.

2 = Corrected data where:

a. The OMNI-PLUS can correct its own magnetometer and VLF total field data when used as a Tie-Line magnetometer or VLF/magnetometer system.

b. The OMNI-PLUS is used as a base station to read the raw data from the field magnetometer or VLF/magnetometer, then correct the total fields by linear interpolation.

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Data Retrieval (con't)

3 = Verification. The field data is dumped through the base station without correction being applied. Rerouting of the data dump cable is not required.

4 = Tie-point drift. The diurnal drift for the individual tie points is retrieved by subtracting the programmable reference field.

5 = Corrected tie-line data. The tie-line data file is dumped directly.

The second digit formats the line number with a compass bearing. The possibilities are as follows:

0 = Standard +/- data presentation.

1 = North (+) or South (-).

2 = East (+) or West (-).

3 = This is a ASCII fixed format for additional computer processing. It is only operable in the PROG or VLF PROG modes.

The third and fourth digits are always zeroes.

6.4 FREQUENCY SELECTION

In the VLF DUMP mode, the operator has the ability to select which VLF station data is to be dumped. The frequency code is recognized in the dump procedure as **PrE 1**. The possibilities are as follows:

1 = The data from the first VLF station measured is dumped.

2 = The data from the second VLF station measured is dumped.

3 = The data from the third VLF station measured is dumped.

4 = The data from all three VLF stations measured are dumped. When transfering three stations to a computer, a file name must be given prior to dumping each station.

Data Retrieval (con't)

6.5 ADJUSTMENT FOR SIGN CONVENTION

As mentioned earlier in this manual, in standard VLF survey methods, a single or consistant direction is used to maintain comparable signs on all VLF in-phase, quadrature or tilt values relative to each other.

The convention used was where profiles plotted looking east (i.e. S to N) and north (i.e. W to E) will have the crossover in the correct sense (positive to negative).

Therefore, the signs are adjusted both in the display and data output so as to follow this sign convention. The OMNI-PLUS uses the sign of the position spacing to determine the sign of the VLF in-phase, quadrature and tilt data. Since, in the OMNI-PLUS, north and east are indicated by a positive sign and south and west as a negative sign, when the operator is facing and walking in the north or east direction (i.e. positive position spacing) the sign of the VLF in-phase, quadrature and tilt data remains as it is measured. If the operator is facing and walking in the south or west direction (negative position spacing) the sign of the VLF data is inverted.

This format is applicable for both the VLF standard and ASCII dump formats. In the ASCII format, there is a column that indicates whether the sign has been inverted (see Section 6.6).

However, if this convention is not applicable to your application, there is the possibility to invert the sign of VLF in-phase, quadrature and tilt data.

During the dumping sequence, the operator can press the FREQ.SELECT key twice whereby the OMNI-PLUS will display 1F NN.N where "N" is a numeric value. If your convention is the reverse than what is described above, then enter a negative sign with the frequency displayed. This procedure has to be implemented for each frequency separately.

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6.6 EDITING FEATURE

In all of the data transfer modes, the operator has the ability to select the start and end points of the block of data to be transferred. This feature must be implemented during the data transfer process while in the DUMP or PROG mode. Also it should be noted that the editing feature is not applicable when using an OLD OMNI IV or PPM base station.

By scrolling through SPECIAL key, the following functions is displayed:

a) **bAUD NN** where N is a numeric value. This is the baud rate for the data transfer. The operator may select a baud rate from 300 (CHANGE + 03 + ENTER) to 9600 (CHANGE + 96 + ENTER).

b) **r 0000.** This is the starting point for the data transfer. As you are aware, each reading stored has a record number or point. The operator may select any record number (CHANGE + NNNN + ENTER, where "N" is a numeric value) as the starting point for the data transfer.

c) **E 0000.** This is the end point for the data transfer. The operator may select any record number (CHANGE + NNNN + ENTER, where "N" is a numeric value) as the end point for the data transfer as long as it is larger than the number used for the starting point.

6.7 PAUSE FEATURE

Any time during the transfer of data from the OMNI-PLUS to the computer or peripheral (noted by the decrementing of the record numbers), the operator can stop the transfer by pressing the SPECIAL key. The transfer of data is reactivated by pressing any other key on the keypad. The pause will remain in effect until another key is pressed or the instrument shuts itself after 29 secords.

TYPE OF DUMP	TYPE OF FIELD UNIT	TYPE OF BASE UNIT	TYPE OF CABLE REQ.	PAGE REF.
UNCORRECTED MAGNETOMETER TOTAL FIELD	OMNI PLUS	N/A	VLX-44(N)*	6-13
CORRECTED MAGNETOMETER TOTAL FIELD	OMNI PLUS	OMNI PLUS NEW OMNI VI	VLX-44(N)	6-15
CORRECTED MAGNETOMETER TOTAL FIELD	OMNI PLUS	OLD OMNI IV	VLX-44(N) VLX-456	6-18
CORRECTED MAGNETOMETER TOTAL FIELD	OMNI PLUS	PPM-400/375	VLX-44(N) VLX-456	6-21
VLF DATA	OMNI PLUS	N/A	VLX-44(N)	6-28
CORRECTED VLF TOTAL FIELD DATA	OMNI PLUS	OMNI PLUS	VLX-44(N)	6-31

*(N) = (3) PRINTER COMPATIBLE (DB25 MALE)
(7) IBM COMPATIBLE (DB25 FEMALE)

Table 6-1
Data Transfer Hardware Summary

6.8 STEP-BY-STEP PROCEDURES FOR TRANSFERING DATA

1) Dumping Uncorrected Magnetometer Data

Interconnect the OMNI-PLUS with the applicable peripheral device using an interface cable as noted in Figure 6-7.

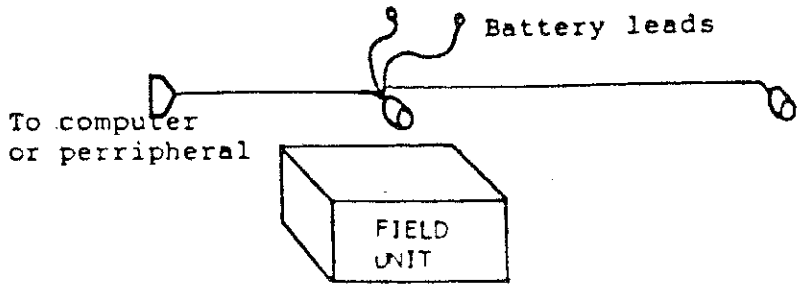

Figure 6-7

Press	MODE	SPACING 9	Until the mode setting DUMP is flashing.
Press	R E A D		A six digit number will appear on the LCD display. The first two digits are a software revision code designation for EDA use only. The third digit is a software code to allow the operator to determine function of the system. The software codes are as follows: 6 = magnetometer total field/VLF 7 = magnetometer base station/VLF 8 = gradiometer/VLF The last three digits is the serial number of the unit.

1) Dumping Uncorrected Magnetometer Data (con't)

Press **A U T O** RECORD — **bAud NN** will be displayed along with the DUMP descriptor, where "N" is a numeric value.

Press **CHANGE** + enter 03 for 300 baud + **ENTER**
+ enter 06 for 600 baud +
+ enter 12 for 1200 baud +
+ enter 24 for 2400 baud +
+ enter 48 for 4800 baud +
+ enter 96 for 9600 baud +

Press **A U T O** RECORD — **HP NNNN** will be displayed along with the DUMP descriptor, where "N" is a numeric value.

Press **CHANGE** + enter 1N00 where if + **ENTER**
N=0 data presentation is standard +/-
N=1 data presentation is North(+) or South(-)
N=2 data presentation is East(+) or West(-)

Power up the peripheral device.

Press **A U T O** RECORD — The display should show the record numbers counting down.

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Data Retrieval (con't)

2) Dumping Corrected Magnetometer Total Field Data Using An OMNI-PLUS or NEW OMNI IV Base Station

On both the base station OMNI-PLUS and the field OMNI-PLUS proceed as follows:

Interconnect the units with the applicable peripheral device using an interface cable as noted in Figure 6-8 and Table 6-1.

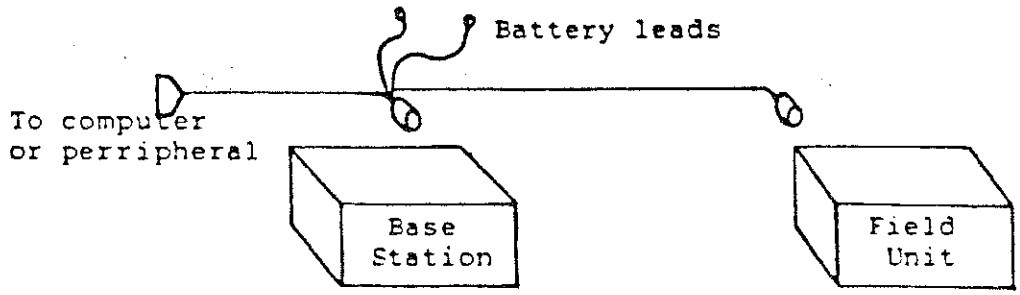

Figure 6-8

Press	MODE	SPACING	Until the mode DUMP is flashing.
		9	
Press	R E A D		A six digit number will appear on the LCD display. The first two digits is a software revision code designation for EDA use only. The third digit is a software code to allow the operator to determine the function of the system. The software codes are as follows: 6 = magnetometer total field/VLF 7 = magnetometer base station/VLF 8 = gradiometer/VLF The last three digits is the serial number of the unit.

2) Dumping Corrected Magnetometer Data Using An OMNI-PLUS or New OMNI IV Base Station (con't)

Press **A U T O** — **bAUd NN** will be displayed along with the DUMP descriptor, where "N" is a numeric value.

RECORD

Press **CHANGE** + enter 03 for 300 baud + + enter 06 for 600 baud + + enter 12 for 1200 baud + + enter 24 for 2400 baud + + enter 48 for 4800 baud + + enter 96 for 9600 baud + **ENTER**

Press **A U T O** — **BP NNNN** will be displayed along with the DUMP descriptor.

RECORD

On the OMNI-PLUS field unit:

Press **CHANGE** + enter 1N00 where if N=0 data presentation is standard +/- N=1 data presentation is North(+) or South(-) N=2 data presentation is East(+) or West(-) + **ENTER**

On the OMNI-PLUS or new OMNI IV base station unit:

Press **CHANGE** + enter 2N00 where N is the same number as used on the OMNI-PLUS field unit. + **ENTER**

2) Dumping Corrected Magnetometer Data Using An OMNI-PLUS or NEW OMNI IV Base Station (con't)

Power up the peripheral device.

On both units SIMULTANEOUSLY:

Press	**A** **U** **T** **O**	The display will show the record numbers counting down.
	RECORD	

Data Retrieval (con't)

3) Dumping Corrected Data Using An OLD OMNI IV Base Station

On both the base station OMNI IV and the field OMNI-PLUS proceed as follows:

Interconnect the units with the applicable peripheral device using an interface cable as noted in Figure 6-6 (**NOTE**: A VLX-456 adaptor cable must be used when combining an OMNI-PLUS with an OLD OMNI IV):

On the OMNI-PLUS field unit:

Press	**MODE**	**SPACING**	Until the mode **DUMP** is flashing.
		9	
Press	**R** **E** **A** **D**		A six digit number will appear on the LCD display. The first two digits is a software revision code designation for EDA use only. The third digit is a software code to allow the operator to determine the function of the system. The software codes are as follows: 6 = magnetometer total field/VLF 7 = magnetometer base station/VLF 8 = gradiometer/VLF The last three digits is the serial number of the unit.

On the OLD OMNI IV base station unit:

Select	**D** **U** **M** **P**	On the mode switch

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3) Dumping Corrected Magnetometer Data Using An OLD OMNI IV Base Station (con't)

Press	**R** **E** **A** **D**	A six digit number will appear on the LCD display. The first two digits is a software revision code designation for EDA use only. The third digit is a software code to allow the operator to determine the function of the system. The software codes are as follows: 3 = magnetometer total field 4 = magnetometer base station 5 = gradiometer The last three digits is the serial number of the unit.

On the OMNI-PLUS field unit:

Press	**A** **U** **T** **O**	**bAUd NN** will be displayed along with the DUMP descriptor, where "N" is a numeric value.

RECORD

Press **CHANGE** + enter 24 for 2400 baud + **ENTER**

NOTE

Only 2400 baud can be used to transfer magnetometer data from the OMNI-PLUS through an OLD OMNI IV or PPM base station magnetometer.

On both units:

Press	**A** **U** **T** **O**	**HP 0000** will be displayed along with the DUMP descriptor.

RECORD

3) Dumping Corrected Magnetometer Data Using An OLD OMNI IV Base Station (con't)

Press	**CHANGE**	+ enter 1N00 where if N=0 data presentation is standard +/- N=1 data presentation is North(+) or South(-) N=2 data presentation is East(+) or West(-) +	**ENTER**

On the OLD OMNI IV base station unit:

Press	**CHANGE**	+ enter 2N00 where N is the same number as used on the OMNI-PLUS field unit. +	**ENTER**

Power up the peripheral device.

On both units <u>SIMULTANEOUSLY</u>:

Press	**A** **U** **T** **O**	The display will show the record numbers counting down.

RECORD

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Data Retrieval (con't)

4) Dumping Corrected Data Using A PPM Base Station

On both the base station PPM and the field OMNI-PLUS proceed as follows:

Interconnect the units with the applicable peripheral device using an interface cable as noted in Figure 6-6 (**NOTE**: A VLX-456 adaptor cable must be used when combining an OMNI-PLUS with an PPM system):

On the OMNI-PLUS field unit:

Press	**MODE**	**SPACING** Until the mode **DUMP** is flashing.
	9	
Press	**R** **E** **A** **D**	A six digit number will appear on the LCD display. The first two digits is a software revision code designation for EDA use only. The third digit is a software code to allow the operator to determine the function of the system. The software codes are as follows: 6 = magnetometer total field/VLF 7 = magnetometer base station/VLF 8 = gradiometer/VLF The last three digits is the serial number of the unit.

On the PPM base station unit:

Select	**D** **A** **T** **C** **O** **R**	On the mode switch
Press	**R** **E** **A** **D**	A six digit number will appear on the LCD display. The last three digits is the serial number of the unit.

4) Dumping Corrected Magnetometer Data Using A PPM Base Station (con't)

On the OMNI-PLUS field unit:

Press	**A** **U** **T** **O**	**bAUd NN** will be displayed along with the DUMP descriptor, where "N" is a numeric value.

RECORD

Press **CHANGE** + enter 24 for 2400 baud + **ENTER**

NOTE

Only 2400 baud can be used to transfer magnetometer data from the OMNI-PLUS through a OMNI IV or PPM base station magnetometer.

Press	**A** **U** **T** **O**	**HP NNNN** will be displayed along with the DUMP descriptor, where "N" is a numeric value.

RECORD

On the PPM base station unit:

Press	**SPOT** **RECORD**	**HP 0000** will be displayed along with the DUMP descriptor.

On the OMNI-PLUS field unit:

Press **CHANGE** + enter 1000 + **ENTER**

On the PPM base station unit:

Press **CHANGE** + enter 4365 + **ENTER**

NOTE

After the 4365 code has been entered into the PPM base station, further data dumps only require the SPOT RECORD key to be pressed. Entering the 4365 code is not required for further data dumps.

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4) Dumping Corrected Magnetometer Data Using A PPM Base Station (con't)

Power up the peripheral device.

On both units SIMULTANEOUSLY:

Press **A** (on the OMNI PLUS)
U
T
O — The display will show the record numbers counting down.

RECORD

SPOT (on the PPM)
RECORD

Data Retrieval (con't)

5) Magnetometer/Gradiometer Profile Plots (for OMNI IV and OMNI-PLUS only)

Profile plots can be developed using the data collected by the OMNI-PLUS. Choose any printer with a width between 40 and 190 characters. If the printer width is 70 characters or less, only the profile plot is printed. Printers wider than 70 characters can accomodate the profile plot and the data. When the paper width is less than 70 characters, the data can be printed out in digital format first using the normal data dump procedures. Then the plot can be performed using the PROG mode. The paper strips can be matched side by side to give the overall format.

Interconnect the line printer and turn on the power.

Press	**MODE**	**SPACING**	Until the mode **PROG** is flashing.
		9	
Press	**R** **E** **A** **D**		A six digit number will appear on the LCD display. The first two digits is a software revision code designation for EDA use only. The third digit is a software code to allow the operator to determine the function of the system. The software codes are as follows: 6 = magnetometer total field/VLF 7 = magnetometer base station/VLF 8 = gradiometer/VLF The last three digits is the serial number of the unit.

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5) **Magnetometer/Gradiometer Profile Plots (for OMNI IV and OMNI-PLUS only)**

Press **A U T O** — **bAUd NN** will be displayed along with the DUMP descriptor, where "N" is a numeric value. (This is only applicable for the OMNI-PLUS unit).

RECORD

Press **CHANGE** + enter 24 for 2400 baud + **ENTER**

NOTE
Only 2400 baud can be used to transfer magnetometer data from the OMNI-PLUS through a OMNI IV or PPM base station magnetometer.

Press **A U T O** — **HP NNNN** will be displayed along with the DUMP descriptor, where "N" is a numeric value.

RECORD

On the OMNI-PLUS field unit:

Press **CHANGE** + enter 1N00 where if + **ENTER**
N=0 data presentation is standard +/-
N=1 data presentation is North(+) or South(-)
N=2 data presentation is East(+) or West(-)

On the OMNI-PLUS/IV base station unit:

Press **CHANGE** + enter 2N00 where N is + **ENTER**
the same number as used on the OMNI-PLUS field unit.

5) Magnetometer/Gradiometer Profile Plots (for OMNI IV and OMNI-PLUS only)

Press	**A** **U** **T** **O**	**CHNNNN** will be displayed on the display along with the PROG descriptor, where "N" is a numeric value.
	RECORD	
Press	**CHANGE** + enter 0NNN where N is the character width of the printer. Any value between 0040 and 0190 may be used. + **ENTER**	
Press	**A** **U** **T** **O**	**+FNNNN** will be displayed along with the PROG descriptor, where "N" is a numeric value.
	RECORD	
Press	**CHANGE** + enter NNNN where N is the total field full scale. The largest field scale that can be used is 9999 gammas. + **ENTER**	
Press	**A** **U** **T** **O**	**GrNNNN** will be displayed along with the PROG descriptor, where "N" is a numeric value.
	RECORD	
Press	**CHANGE** + enter NNNN where N is the gradient full scale. The largest field scale that can be used is 9999 gammas. If no gradient data was recorded enter for N all zeroes. + **ENTER**	

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5) Magnetometer/Gradiometer Profile Plots (for OMNI IV and OMNI-PLUS only)

Press **A U T O** RECORD — The display will show the record numbers counting down.

```
OMNI-PLUS  Tie-line MAG/VLF V12F  Ser  #18055
TOTAL FIELD DATA (uncorrected)
& GRADIENT

Reference field: 56800.0
Datum subtracted:      0.0Date 15 JUL 88
Operator:  5002
Records:  755
Bat:  17.3 Volt     Lithium:  3.46 Volt
Last time update:  7/12  8:30:00
Start  of  print:  7/22 15:16:00


Line  4+00 N  Date 15 JUL 88          #60
POSITION   FIELD  ERR    DRIFT    TIME     DS FIELD=X GRAD=+
  0+625E 56369.7 .00       0.0 10:23:30 28          .       .   + X   .       .
  0+50 E 56369.7 .00       0.0 10:23:50 28          .       .   + X   .       .

Line 12+00 N  Date 15 JUL 88          #62
POSITION   FIELD  ERR    DRIFT    TIME     DS FIELD=X GRAD=+
  0+00 E 60725.2 .04       0.0 10:46:11 88          .  X    .       .       .   +
  0+125W 60558.9 .04       0.0 10:46:49 88          .*      .       .       .
  0+25 W 60542.6 .04       0.0 10:47:15 88         +X       .       .       .
  0+375W 60750.5 .04       0.0 10:47:43 88+         .   X   .       .       .
  0+50 W 60868.5 .04       0.0 10:48:12 88          .     X . +     .       .
  0+625W 60957.6 .04       0.0 10:48:44 88          .      X.       .       +
  0+75 W 60890.0 .04       0.0 10:49:02 88          .      X .     + .       .
  0+875W 61139.9 .06       0.0 10:49:32 88          .        . X   + .       .
  1+00 W 61221.5 .06       0.0 10:49:50 88          .        .  X    .       .   +
  1+125W 60502.2 .05       0.0 10:50:13 88+        X         .       .       .
  1+25 W 60429.4 .05       0.0 10:50:31 88        X.         .       .   +   .
  1+375W 60409.7 .04       0.0 10:50:54 88       X  .        .       .+      .
  1+50 W 60348.3 .04       0.0 10:51:15 88      X   .       +.       .       .
  1+625W 60221.3 .04       0.0 10:51:38 88   X     .        .       .       .   +
  1+75 W 60173.9 .04       0.0 10:52:05 88   X     .        .       .   +   .
```

Figure 6-9
Magnetometer Profile Plot

6) Dumping VLF Data

Interconnect the OMNI-PLUS with the applicable peripheral device using an interface cable as noted in Figure 6-5.

NOTE

The VLF total field data from the OMNI-PLUS is uncorrected.

Press	**MODE**	**SPACING** 9	Until the mode **VLF DUMP** is flashing.
Press	**R E A D**		A six digit number will appear on the LCD display. The first two digits is the software revision code designation for EDA use only. The third digit is a software code to allow the operator to determine the function of the system. The last three digits are the serial number of the unit.
Press	**A U T O**		**bAUd NN** will be displayed along with the VLF DUMP descriptors, where "N" is a numeric value.

RECORD

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6) Dumping VLF Data (con't)

Press **CHANGE** + enter 03 for 300 baud + **ENTER**
+ enter 06 for 600 baud +
+ enter 12 for 1200 baud +
+ enter 24 for 2400 baud +
+ enter 48 for 4800 baud +
+ enter 96 for 9600 baud +

Press **A U T O** RECORD — **EPNNNN** will be displayed along with the VLF DUMP descriptors, where "N" is a numeric value.

Press **CHANGE** + enter 1N00 where if + **ENTER**
N=0 data presentation is standard +/-
N=1 data presentation is North(+) or South(-)
N=2 data presentation is East(+) or West(-)

Press **A U T O** RECORD — **FrE 1** will be displayed along with the VLF DUMP descriptors.

Press **CHANGE** + enter: 1 for dumping the first VLF station. + **ENTER**
: 2 for dumping the second VLF station.
: 3 for dumping the third VLF station.
: 4 for dumping all three VLF stations.

6) Dumping VLF Data (con't)

Press	A U T O RECORD	The display will show the record numbers counting down.

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Data Retrieval (con't)

7) Dumping Corrected VLF Total Field Data Using An OMNI-PLUS Base Station

On both the base station and field OMNI-PLUS proceed as follows:

NOTE

VLF total field data can only be corrected using an OMNI-PLUS Base Station or Gradiometer.

Interconnect the units with the applicable peripheral device using an interface cable as noted in Figure 6-6 and Table 6-1.

Press	MODE	SPACING 9	Until the mode VLF DUMP is flashing.
Press	R E A D		A six digit number will appear on the LCD display. The first two digits is the software revision code designation for EDA use only. The third digit is a software code to allow the operator to determine the function of the system. The software codes are as follows: 6 = magnetometer total field/VLF 7 = magnetometer base station/VLF 8 = gradiometer/VLF The last three digits is the serial number of the unit.
Press	A U T O		bAUd NN will be displayed along with the VLF DUMP descriptors, where "N" is a numeric value.

RECORD

Data Retrieval (con't)

Press **CHANGE** + enter 03 for 300 baud + **ENTER**
+ enter 06 for 600 baud +
+ enter 12 for 1200 baud +
+ enter 24 for 2400 baud +
+ enter 48 for 4800 baud +
+ enter 96 for 9600 baud +

Press **A** **HP NNNN** will be displayed along
U with the VLF DUMP descriptors,
T where "N" is a numeric value.
O

RECORD

On the field unit:

Press **CHANGE** + enter 1N00 where if + **ENTER**
N=0 data presentation is
standard +/-
N=1 data presentation is
North(+) or South(-)
N=2 data presentation is
East(+) or West(-)

On the base station unit:

Press **CHANGE** + enter 2N00 where N is the + **ENTER**
same number as used on the
field unit.

On both units:

Press **A** **FrE 1** will be displayed along with
U the VLF DUMP descriptors, where "N"
T is a numeric value.
O

RECORD

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Data Retrieval (con't)

Press **CHANGE** + enter: 1 for dumping the first VLF station. : 2 for dumping the second VLF station. : 3 for dumping the third VLF station. : 4 for dumping all three VLF stations. + **ENTER**

Power up the peripheral device.

On both units SIMULTANEOUSLY:

Press **A** **U** **T** **O** **RECORD** The display will show the record numbers counting down.

Data Retrieval (con't)

8) VLF In-phase/Quadrature and Total Field Profile Plots

Profile plots can be developed using the data collected by the OMNI-PLUS. Choose any printer with a width between 40 and 190 characters. If the printer width is 70 characters or less, only the profile plot is printed. Printers wider than 70 characters can accomodate the profile plot and the data. When the paper width is less than 70 characters, the data can be printed out in digital format first using the normal data dump procedures. Then the plot can be performed using the PROG mode. The paper strips can be matched side by side to give the overall format.

Interconnect the line printer and turn on the power.

Press	MODE	SPACING Until the mode VLF PROG is flashing.
	9	
Press	R E A D	A six digit number will appear on the LCD display. The first two digits is a software revision code designation for EDA use only. The third digit is a software code to allow the operator to determine the function of the system. The software codes are as follows: 6 = magnetometer total field/VLF 7 = magnetometer base station/VLF 8 = gradiometer/VLF The last three digits is the serial number of the unit.

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8) VLF In-ohase/Quadrature and Total Field Profile Plots

Press **A U T O** — **bAUd NN** will be displayed along with the DUMP descriptor, where "N" is a numeric value. (This is only applicable for the OMNI-PLUS unit).

RECORD

Press **CHANGE** + enter 03 for 300 baud +
+ enter 06 for 600 baud +
+ enter 12 for 1200 baud +
+ enter 24 for 2400 baud +
+ enter 48 for 4800 baud +
+ enter 96 for 9600 baud + **ENTER**

Press **A U T O** — **BP NNNN** will be displayed along with the DUMP descriptor, where "N" is a numeric value.

RECORD

On the OMNI-PLUS field unit:

Press **CHANGE** + enter 1N00 where if + **ENTER**
N=0 data presentation is standard +/-
N=1 data presentation is North(+) or South(-)
N=2 data presentation is East(+) or West(-)

On the OMNI-PLUS/IV base station unit:

Press **CHANGE** + enter 2N00 where N is + **ENTER**
the same number as used on the OMNI-PLUS field unit.

Data Retrieval (con't)

8) VLF In-phase/Quadrature and Total Field

Press **A U T O** — **FrE 1** will be displayed along with the VLF DUMP descriptors.

RECORD

Press **CHANGE** + enter: 1 for dumping the first VLF station. : 2 for dumping the second VLF station. : 3 for dumping the third VLF station. : 4 for dumping all three VLF stations. + **ENTER**

Press **A U T O** — **CHNNNN** will be displayed on the display along with the PROG descriptor, where "N" is a numeric value.

RECORD

Press **CHANGE** + enter 0NNN where N is the character width of the printer. Any value between 0040 and 0190 may be used. + **ENTER**

Press **A U T O** — **tFNNNN** will be displayed along with the PROG descriptor, where "N" is a numeric value.

RECORD

NOTE

The full scale for the in-phase and quadrature is always 100 percent (i.e. $\pm$ 50 percent). For corrected total field the full scale is always 200 percent, where the zero point (i.e. center) is 100 percent. For uncorrected total field strength, the full scale is programable.

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Data Retrieval (con't)

8) VLF In-phase/Quadrature and Total Field

Press	**CHANGE**	+	enter NNNN where N is the total field full scale.	+	**ENTER**
Press	**A** **U** **T** **O**		The display will show the record numbers counting down.		

RECORD

```
MNI-PLUS  Tie-line MAG/VLF V12F  Ser  #18055
VLF TOTAL FIELD DATA (uncorrected)
Date 15 JUL 88
perator:  5002
ecords:  755
Bat:  17.3 Volt     Lithium:  3.46 Volt
ast time update:  7/12  8:30:00
tart  of  print:  7/22 14:45:57


ine  0+00 N  Date 15 JUL 88  21.4     #1
OSITION  VLF - TOTAL FLD = X   IN-PHASE = +  QUAD = #
                      -30           -10            10            30            50
   #1   .      X      .              .     #       .             +

Line  4+00 N  Date 15 JUL 88  21.4     #2
POSITION  VLF - TOTAL FLD = X   IN-PHASE = +  QUAD = #
                      -30           -10            10            30            50
 7+75 E .             .              .+       #     .           X .
 7+75 E .             .              .+       #     .          X  .
 7+625E .             .              .+       #     .            X.
 7+50 E .             .              . +      #     .            X.
 7+375E .             .              . +      #     .            X.
 7+25 E .             .              . +      #     .            X.
 7+125E .             .              .+       #     .            X.
 7+00 E .             .              .+       #     .            X.
 6+875E .             .              .+       #     .             X
 6+75 E .             .              +        #     .            X.
 6+625E .             .           +  .        #    .             X
 6+50 E .             .        +     .     #      .              . X
 6+375E .             .              .+       #     .              .     X
 6+25 E .             .              .  +       #   .              .   X
```

Figure 6-10
VLF Profile Plot

Data Retrieval (con't)

9) Performing The ASCII Fixed Format CPU Dump

As discussed previously, all ASCII magnetometer and VLF data is transferable only through the PROG mode. The magnetometer data will be transfered through the PROG mode and the VLF data will be transfered through the VLF PROG mode.

Interconnect the OMNI-PLUS with the applicable computer or peripheral using an interface cable as noted in Figure 6-5 (Table 6-1) for the uncorrected VLF and magnetometer total field data and as in Figure 6-6 (Table 6-1) for corrected magnetometer or VLF total field data.

NOTE

The ASCII format noted in figure 6-2 is not obtainable using a PPM base station.

Instructions for Transferring OMNI-PLUS/OMNI IV Data to a Computer

If a computer is used:

A. Computer

1. Connect OMNI system to the RS-232 serial port of the computer as described in Section 6 of the OMNI-PLUS Manual.

2. Load in the BASIC.EXE compatible with your computer as follows: (GWBASIC/C:1024)

3. Press F3 and type in MAGDUMP.CMX <return>

   - where X = CM1 (9600 baud, COM1)
   - where X = CM2 (2400 baud, COM2)
   - where X = CM3 (2400 baud, COM1)

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MAGDUMP PROGRAM

```
5 LF$=CHR$(10) 'LINE-FEED CHARACTER
8 ON ERROR GOTO 300
10 INPUT "ENTER FILENAME (i.e. B:FILE.EXT) ";A$
20 OPEN A$ FOR OUTPUT AS #2
30 OPEN "COM1:2400,N,8,2,RS,CS,DS,lf" FOR INPUT AS #1
40 PRINT"CONNECT MAG, PRESS READ & AUTO INC"
50 LINE INPUT #1,B$
60 L=LEN(B$) : IF LEFT$(B$,1)=LF$ THEN B$=MID$(B$,2,L)
68 PRINT B$
70 IF L>8 THEN F=1
72 IF F=0 THEN 100
76 IF L<8 THEN C=C+1 ELSE C=0
80 IF C>5 THEN 200
100 PRINT #2,B$
120 GOTO 50
200 CLOSE
220 PRINT "FILE  ",A$,"  FINISHED"
230 GOTO 999
300 PRINT "** ERROR# ";ERR,"ON LINE# ";ERL,"*****"
350 PRINT "** TURN MAGNETOMETER OFF & TRY AGAIN **"
400 PRINT "MAKE SURE TO LOAD BASICA WITH  /C:1024  IF BUFFER OVERFLOW OCCURS"
999 END
```

4. Press F2 and enter in a filename <return>

B. OMNI-PLUS (OMNI IV)

1. Select Mode (VLF PROG for VLF data)
   (PROG for magnetometer data)

2. Press **READ**

3. Press **AUTO RECORD**

4. Press **CHANGE** & enter baud rate & **ENTER** (as per Line 30 of program) (this step is for the OMNI-PLUS only - use 2400 baud when using the OMNI PLUS with an OMNI IV or PPM base station)

5. Press **AUTO RECORD**

6. Press **CHANGE** & enter in HP code (as per manual) & **ENTER**

7. Press **AUTO RECORD**

At this point the data should be appearing on the computer screen and the record points, counting down on the LCD display of the OMNI's.

Data Retrieval (con't)

9) Performing The ASCII Fixed Format CPU Dump

Press	**MODE**	**SPACING**	Until the mode PROG is flashing for magnetometer data or VLF PROG for VLF data.
		9	
Press	**R** **E** **A** **D**		A six digit number will appear on the LCD display. The first two digits is a software revision code designation for EDA use only. The third digit is a software code to allow the operator to determine the function of the magnetic portion of the system. The software codes are as follows: 6 = magnetometer total field/VLF 7 = magnetometer base station/VLF 8 = gradiometer/VLF The last three digits is the serial number of the unit.
Press	**A** **U** **T** **O**		bAUd NN will be displayed along with the PROG or VLF PROG descriptor, where "N" is a numeric value.

RECORD

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8) Performing The ASCII Fixed Format CPU Dump (con't)

Press	CHANGE	+ enter 03 for 300 baud + + enter 06 for 600 baud + + enter 12 for 1200 baud + + enter 24 for 2400 baud + + enter 48 for 4800 baud + + enter 96 for 9600 baud +	ENTER
Press	A U T O RECORD	HPNNNN will be displayed along with the PROG or VLF PROG descriptor, where "N" is a numeric value.	
Press	CHANGE	+ enter N300 where N is the the type of data to be retrieved. For a field unit enter N=1 and for a base station enter N=2. +	ENTER
Press	A U T O RECORD	The display will show the record numbers counting down.	

6.9 Specifications of the ASCII Fixed Format CPU Dump

As previously mentioned, there are two ASCII CPU dumps:

-Magnetometer ASCII CPU dump accessed through the **PROG** mode.
-VLF ASCII CPU dump accessed through the **VLF PROG** mode.

In the ASCII CPU dumps, the fields are rigidly defined.

First, there are a few empty lines with: 'cr,lf,nul,nul". All the lines with data start with a three character alphanumeric field, not belonging to the data, but defining what type of data/header it is:

'H0' first line of header data.
'H1' second line of header data.
'H2' third line of header data.
'H3' fourth line of header data.
'H4' fifth line of header data.
'H5' sixth line of header data.

'D' magnetometer data, preceding each line of magnetometer measurement data.

'V1' VLF data of the first station measured, preceeding each line of the VLF data.

'V2' VLF data of the second station measured, preceeding each line of the VLF data.

'V3' VLF data of the third station measured, preceeding each line of VLF data.

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6.9 Specifications of the ASCII Fixed Format CPU Dumps (con't)

Magnetometer ASCII Fixed Format CPU Dump

DATA FORMAT FOR FIELDMAG or GRADIOMETER DATA (corrected and uncorrected). BASE STATION (uncorrected) DATA EXITS OUT OF THE FIRST 26 FIELDS, including 'C' for the checksum.

```
         1         2         3         4         5         6
12345678901234567890123456789012345678901234567890123456789012345678901234

D  1219112231 563697 1123  561234  42000 -55125 250078 561234 11

xxxMMDDHHMMSSFFFFFFFRRRRRCBBBBBBBLLLLLLLPPPPPPP EEEEDSGGGGGGG NN
```

Format	Column	Description
xxx	1-3	3 character alphanumeric preamble for measurement data (always 'D').
MMDDHHMMSS	4-13	10 character numeric field for date and time.
FFFFFFF	14-20	7 character numeric field for raw upper sensor data, with implied decimal point before the last digit, ie, 56123.4 gamma.
RRRRR	21-25	5 character numeric field for the reading number (or record pointer 'RPxxxx' on display).
C	26	1 alphanumeric character checksum error (blank if all OK).
BBBBBBB	27-33	7 character numeric field for corresponding base station reading to be used for diurnal correction.
LLLLLLL	34-40	7 character numeric field for line number with implied decimal point before the last digit, and preceded by a '-' sign if either S or W '-121250' = 121S+25 or 12125 S.
PPPPPPP	41-47	7 character signed numeric field for station or position number in the same way as the LINE number.
EEEE	49-52	4 character numeric field for error with implied decimal point after the second digit, ie, xx.xx.

6.9 Specifications of the ASCII Fixed Format CPU Dump (con't)

Format	Column	Description
D	53	1 character numeric field for the decay rate (1 to 8).
S	54	1 character numeric field for the sensor strength (1 to 8).
GGGGGGG	55-61	7 character numeric field for the raw field strength of the bottom sensor with the implied decimal point before the last digit. This value minus the upper sensor strength gives the gradient.
NN	62-64	3 character number denoting the cultural feature. A detailed description is given in Table 4-3.

VLF ASCII CPU Dump

```
      1         2         3         4         5         6         7
234567890123456789012345678901234567890123456789012345678901234567890123456789012

  1107080114 561234 1123* 561234  42000 -55125 250078 561234 B0G
1 214 -1234  2304   6789  -990 89   -17--110   6700   5107    234
2 248   164    38     92    93 62   321-  20     91  14270    250
3 240    19   -69    315    10 49  -890- 110    302  15170    255

xx SSS111111IQQQQQQFFFFFFFTTTTTT HhJJJJJJjkkL1MMMMMMMmmmmmmmmNNNNNNNnnnnnnn
```

Format	Column	Description
xxx	1-3	3 character alphanumeric preamble for measurement data: V1 for the first station. V2 for the second station. V3 for the third station.
SSS	4-6	3 character numeric field denoting the VLF station frequency in kHz (implied decimal point before the last digit).
IIIIII	7-12	6 character numeric field denoting the in-phase value in percent for that station. This field may include a '-' sign and a floating decimal point.

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6.9 Specifications for the ASCII Fixed Format CPU Dumps (con't)

Format	Column	Description
QQQQQQ	13-18	6 character numeric field denoting the vertical quadrature value in percent for that particular station. This field may include a '-' sign and a floating decimal point.
FFFFFFF	19-25	7 character numeric field denoting the total field value for that particular station. These values will always be positive.
TTTTTT	26-31	6 character numeric field denoting the tilt angle value for that particular station. This field. This may include a '-' sign and a floating decimal point.
H	33	1 character numeric field denoting the operator quality. This value is preceeded by a blank.
h	34	1 character numeric field denoting the signal/noise ratio.
JJJJJJ	35-40	6 character numeric field denoting the angle value for that particular station. This may include a '-' sign and a floating decimal point.
j	41	1 character field denoting a sign correction on the in-phase, quadrature and tilt data based on the line direction.
k	42	1 character field denoting a sign correction on the in-phase, quadrature and tilt data by inverting the sign on the frequency.
K	43	1 character field denoting changes to the calculation of the internal Fraser Filter. If a ! appears this is an invalid reading for filtering. If a # appears, this is a repeat reading at a station and the previous reading at that location was used for filtering.
L	44	1 character field denoting either Mode 1 or Mode 2.
l	45	1 character field denoting an error in the VLF. A description of the errors can be found in Section 9.
MMMMMMM	46-52	7 character numeric field denoting the corresponding base station reading to be used for primary field correction. This value will always be positive.

6.9 Specifications for the ASCII Fixed Format CPU Dumps (con't)

Format	Column	Description
mmmmmmm	53-59	7 character numeric field denoting the apparent resistivity. This field may include a floating decimal point.
NNNNNN	60-65	6 character numeric field denoting the phase angle. This field may include a floating decimal point.
n nnnnn	66-72	7 character numeric field denoting either vector resistivity or ellipticity. This is only applicable with the resistivity version of the OMNI PLUS.

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6.9 SPECIFICATIONS FOR THE ASCII FIXED FORMAT CPU DUMP (con't)

NOTES

MAGNETOMETER

i) The uncorrected total field data is the raw upper sensor data. The base station reading given has only be adjusted to the time of the total field reading. To obtain the corrected total field reading, the following formula must be used:

Uncorrected total field (FFFFFFF) - base reading (BBBBBBB) + reference field (RRRRRRR under the 'HI' header)

ii) To obtain the vertical gradient, subtract the raw upper sensor from the raw lower sensor. Although the sensor separation is only 0.5 meters, the lower sensor reading has been adjusted to read as gammas per meter.

VLF

i) The signs (+ve/-ve) of the in-phase, quadrature and tilt data has been adjusted for line direction. In other words, the signs have been adjusted as if the operator was facing north or east for all readings. To obtain the original values, multiply the data by column 41 of the VLF ASCII dump.

ii) The corrected VLF total field is calculated as a ratio. To obtain this ratio, the following formula must be used:

VLF total field strength (FFFFFFF) / VLF base field strength (MMMMMMM) x 100.

This ratio is calculated and given under VLF DUMP.

6.9 SPECIFICATIONS FOR THE ASCII FIXED FORMAT CPU DUMP (con't)

Header Formats:

'HO IISSSSSSXXYYRRRRRROOOOHHhhMMMMVVVV'

'HO'	3 character alphanumeric field for the first header line.
II	2 character numeric field for instrument code.
SSSSSS	6 character numeric field for serial number.
XX	2 character numeric field (00 if uncorrected mag, 99 if corrected mag).
YY	2 character numeric field (internal record length).
RRRRRR	6 character numeric field for the number of records or readings
OOOO	4 character numeric field for the operator number.
HH	2 character numeric field for HP CODE used in field unit.
hh	2 character numeric field for HP-CODE used in base station (correcting mag).
MMMM	4 character numeric field for main battery voltage.
VVVV	4 character numeric field for lithium battery voltage.

'HI PPPPPPPLLLLLLLRRRRRRRDDDDDDD'

'HI	3 character alphanumeric preamble for 2nd header line.
PPPPPPP	7 character numeric field for position or station of base mag (if used).
LLLLLLL	7 character numeric field for line of base station mag (if used).
RRRRRRR	7 character numeric field for the magnetometer base-reference field.
DDDDDDD	7 character numeric field for the magnetometer datum field or grid.

'H2 MMDDHHMMSSmmddhhmmssMMDDHHMMSS'

'H2'	3 character alphanumeric preamble for 2nd header line.
MMDDHHMMSS	10 character numeric field for time of field mag time update.
mmddhhmmss	10 character numeric field for time of first reading of survey.
MMDDHHMMSS	10 character numeric field for time of data dump. All times are in month/day, hour: minute: seconds format,
H3	3 character alphanumeric preamble for 3rd header line.

All data fields are the same as for 'H2', except that the times apply to the base station mag use in the correction mode (if applicable).

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6.9 SPECIFICATIONS FOR THE ASCII FIXED FORMAT CPU DUMP (con't)

H4	3 character alphanumeric preamble for 4th header line.

No data fields presently specified (for future expansion only).

'H5 TTTTTTTT'	
'H5'	3 character alphanumeric preamble for 5th header line.
TTTTTTTT	8 character alphanumeric preamble for the eprom software in the console and module.

SECTION 7

STEP-BY-STEP PROCEDURES FOR USING THE TIE-LINE OR LOOPING METHOD

7a) TIE-LINE METHOD

For this survey method, there is no base station. Therefore, in order to utilize the data correction algorithms in the OMNI-PLUS microprocessor, it is necessary to establish a base station (or base point) reference as well as a series of tie points (usually along the same tie line). Tie line(s) are usually located along the strike length of the survey grid, and either along the baseline or at the ends of the grid lines.

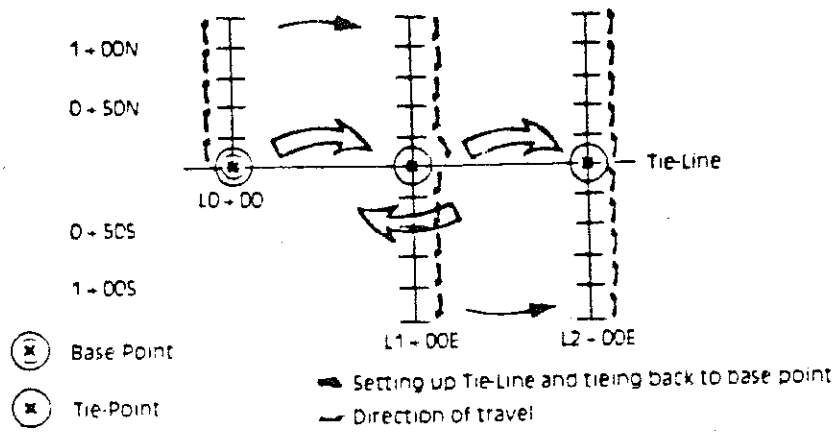

Figure 7-1
Diagram Showing the Tie-Line Survey Method

NOTE

The tie-point readings form a bench mark for computing diurnal variations so that the survey readings can be corrected. Therefore, at each reading, the correct survey grid coordinates (ie, line and position) must be recorded simultaneously. Erroneous data must be deleted or readings must be repeated. Reading at the base reference point can be stored in the tie-line memory by selecting:

TIE mode - correcting the magnetometer total field or for correcting both the magnetometer and VLF total field.

VLF TIE mode - for correcting the VLF total field only.

7a) TIE-LINE METHOD, (con't)

The recording are entered using the SPOT RECORD - TIE BASE key. Check the reading quality display (i.e. magnetometer - SENSOR and DECAY; VLF OPERATOR QUALITY and SIGNAL/NOISE). Discard a poor reading by pressing the OFF key. Then take a repeat reading by using the SPOT RECORD for the base reference point or the MULTI RECORD for the tie points. If the quality is poor for multiple readings, move the tie point to a location where good quality and repeatability can be obtained. The location of the base reference point should be selected in an area with low magnetic gradient and conductivity.

At this point, the operator should assemble the instrument and proceed to the site. The VLF Sensor coils require to be calibrated and this should be performed away from any sources that may affect the coils (ie, video displays).

<u>At the base reference point:</u>

CAUTION

Prior to initializing the system, ensure you are facing in the same direction of the lines being surveyed. Also, ensure that the magnetometer sensor is oriented with its North mark facing north and the cable is attached securely to the OMNI-PLUS.

Press	MODE	SPACING	Until the mode setting TEST is flashing.
		9	
Press	R E A D	A U T O	OP NNNN will be displayed along with the TEST and BATT descriptors, where "N" is a numeric value.

RECORD

NOTE

If OPNNNN does not appear, perform a dumping sequence as described in Section 6 (without being connected to a computer or peripheral).

Press CHANGE + 3MNN for TFM / 4MNN for BASE / 5MNN for GRAD + ENTER

where: M= 9 if alkaline batteries are used.
M= 0-8 if rechargeable batteries are used.
N= 0-7 for all three values. These three values are the operator code.

7a) TIE-LINE METHOD, (con't)

Note: **1)** Once the new operator code has been entered, recovery of the data stored prior to entry of the new code will **NOT BE POSSIBLE THROUGH THE DUMP MODES.**

2) For VLF only, it is suggested that 3MNN be used for field surveys and 4MNN for base station operation.

Press **A**
U
T
O

RECORD

Automatically, 1F NN.N will be displayed along with the VLF, TEST and BATT descriptors, where "N" is a numeric value. The NN.N will be flashing. The operator has the ability to measure three VLF stations: 1F, 2F and 3F. The frequencies are programmed in kHz with the decimal point fixed. To enter in the frequency:

Press **CHANGE** + the frequency of the station + **ENTER**
to be measured (ie, 24.0 Cutler).

Press **A**
U
T
O

RECORD

For Resistivity Option Only

Automatically, lrSPNN.N will be displayed, where "N" is a numeric value. This is the electrode spacing for the resistivity option. A spacing of 5, 10 or 20 may be entered. If "0" is entered, then the resistivity (VLF electric) measurements are disabled. To enter the spacing:

Press **CHANGE** + 5, 10 or 20 + **ENTER**

Press **A**
U
T
O

RECORD

NOTE

Although no resistivity value may be needed at the base reference point, the initialization process requires the electrodes to be attached and set-up as instructed in Section 10 of this manual.

7a) TIE-LINE METHOD, (con't)

Automatically, 2F 00.0 will be displayed along with the VLF, TEST and BATT descriptors. To enter in the frequency of this station:

Press **CHANGE** + the frequency of the station + **ENTER**
to be measured (ie, 24.8 Seattle)

Press **A**
U
T
O

RECORD

For Resistivity Option Only

If a frequency other than 00.0 is selected then 2rSPNN.N will be displayed where "N" is a numeric value. If a resistivity/VLF electric/measurement is required:

Press **CHANGE** + 5, 10 or 20 + **ENTER**

Press **A**
U
T
O

RECORD

Automatically, 3F 00.0 will be displayed along with the VLF, TEST and BATT descriptors. To enter in the frequency of this station:

Press **CHANGE** + the frequency of the station + **ENTER**
to be measured.

For Resistivity Option Only

If a frequency other than 00.0 is selected, then 3rSPNN.N will be displayed, where "N" is a numeric value. If a resistivity (VLF electric) measurement is required, enter in either 5, 10 or 20 as described previously.

Note: If only two VLF stations are to be measured, enter 00.0 for the third frequency. If only one VLF station is to be measured, enter 00.0 for the second and third frequencies.

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7a) TIE-LINE METHOD, (con't)

Press **A U T O** — **PNNNN** will be displayed where "N" is a numeric value.

RECORD

NOTE

As described earlier, the OMNI-PLUS corrects the VLF readings for line direction. Enter either a positive or negative position spacing that corresponds to the direction you will be travelling.

Press **CHANGE** + positive or negative position spacing. + **ENTER**

At this point, stand still, face the direction you will be performing the survey and:

Press **A U T O** — **init** will appear on the display.

RECORD

The system is now calibrating the VLF coils. This process takes approximately 30 seconds and during this period the operator should stand still and do not press any of the keys (unless the audio alarm is activated. At this time, press the VLF key). During this initialization process, "init" is displayed and the system is automatically setting the gain settings for the VLF frequencies selected. When the calibration is completed, 1 NNNN will be shown on the display, where "NNNN" is the calibrated field value for the first frequency.

The values expected are as follows:

FIELD	2000-4000	Induced calibration field strength.
PHASE	70.7 +/- 3%	Checking the electronic matching of the channels. A malfunctioning channel will be indicated by a value outside of the allowable value.
QUAD	01 or 02	Mode setting (see Section 9).
TILT	01 to 17	Gain setting (see Section 9).

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7a) TIE-LINE METHOD, (con't)

Press	TIEBASE (twice) – SPOT RECORD	The calibration values are now stored. It would be a good policy to store the calibration readings at the start of each day or any time during the day when an initialization process is performed.

At this time, the operator should determine whether a satisfactory signal is being received from the VLF stations.

Press	MODE SPACING 9	Until the mode setting TIE is flashing or VLF TIE.
Press	R E A D	The unit will display the parameter (magnetometer of VLF) which was last viewed on the previous reading. When the VLF and magnetometer signals have been measured, the new value of the last parameter viewed will be displayed.
Press	TIEBASE – SPOT RECORD	LP9999 will be displayed along with the BATT and TIE descriptors. This designation tells the operator that this is the base reference point.
Press	TIEBASE – SPOT RECORD	The data is stored and the unit shuts off automatically.

Proceed to the first tie-point position:

Press	R E A D	The unit will display the parameter (magnetometer or VLF) which was last viewed on the previous reading. When the VLF and magnetometer signals have been measured, the new value of the last parameter viewed will be displayed.
Press	MULTI RECORD	L NNNN will be displayed where N is the first line programmed by the operator in memory.
Press	MULTI RECORD	The data is stored and the unit shuts off automatically.

7a) TIE-LINE METHOD, (con't)

Proceeding to the next tie-point position:

Press	**R** **E** **A** **D**	The unit will display the parameter (magnetometer or VLF) which was last viewed on the previous reading. When the VLF and magnetometer signals have been measured, the new value of the last parameter viewed will be displayed.
Press	**A** **U** **T** **O** **RECORD**	**L NNNN** will be displayed where N is the next sequential line number. Verify that this is the correct line number for the tie-point. The flashing L denotes a tie-line reading.
Press	**A** **U** **T** **O** **RECORD**	The data is stored and the unit shuts off automatically.

This proceedure is repeated until a reading has been measured and stored at all of the tie-points.

CAUTION

Proceed as quickly as possible to minimize the effects of diurnal variations. If scattered tie-point locations are selected, it will be necessary to correct the line and position displays.

Upon completion of measuring all the tie-points:

Return to the base reference point.

Press	**R** **E** **A** **D**	The unit will display the parameter (magnetometer or VLF) which was last viewed on the previous reading. When the VLF and magnetometer signals have been measured, the new value of the last parameter viewed will be displayed.
Press	**TIEBASE** **-** **SPOT RECORD**	**LP9999** will be displayed along with the BATT and TIE descriptors. This designation tells the operator that this is the base reference point.
Press	**TIEBASE** **-** **SPOT RECORD**	The data is stored and the unit shuts off automatically.

7a) TIE-LINE METHOD, (con't)

The reading and grid coordinates will be stored in the special tie-line memory. Therefore, there will be two readings entered for the base reference point: One at the beginning and one at the end of the tie-point reference measurements. These two readings will indicate the diurnal variation between them and the elasped time between the two readings.

At this point, the operator can proceed with the field survey in the TFM, GRAD or VLF mode. Please note that the line value will have to be changed if you are not starting your survey on your last tie-point line. Also, ensure that you start and end on one of the tie-points.

NOTE

On subsequent survey days, the first and last reading of the day must be recorded at the base reference point or at any given tie point stored in memory. These must be stored in the TIE mode.

Extending the Tie-Point Grid:

If the survey grid is extended, it is possible to increase the number of tie-line references in the tie-line memory at any time or day during the survey. Previous tie-line readings will remain in memory until they are erased by the HP8888 dump code.

To extend the grid, an established tie-point which is located nearest to your new area will be selected as the new "base reference point". At this tie-point, take a reading under one of the normal reading modes (TFM,GRAD or VLF) and store the reading under MULTI RECORD **(NOTE: ENSURE THAT THIS READING HAS THE SAME GRID COORDINATES AS PREVIOUSLY STORED AS A TIE-POINT).** Proceed to the new tie-points, storing these readings in either TIE or VLF TIE, mode. After completing the readings at the new tie-points, proceed quickly to the previous tie-point you are using as the new "base reference point".

At this location, take a reading under one of the normal reading modes (TFM, GRAD or VLF). Store the reading under MULTI RECORD ensuring the grid coordinates are correct. At this point, you are ready to proceed with the survey using one of the normal reading modes.

Displaying the Tie-Point Drift:

The diurnal drift between the two most recent measurements at the tie points can be monitored as follows:

a. Ensure that the MODE selector is set to TIE or VLF TIE.

b. Press the DRIFT key. The display will show a value which is the drift between the last two consecutive tie points.

7a) TIE-LINE METHOD, (con't)

CAUTION

Do not initialize the tie-line memory again until the survey is complete.

Storing of Tie-Line Data:

Both the magnetic and VLF data is stored in the internal memory of the OMNI-PLUS and can be accessed through the dump modes (See Section 6).

Clearing the Tie-Line Memory:

The TIE memory is cleared as follows:

Press	MODE	SPACING	Until these mode setting DUMP or VLF DUMP is flashing.
		9	
Press		R E A D	A six digit number will appear on the LCD display. The first two digits is a software revision code designation for EDA use only. The third digit is a software code to allow the operator to determine the function of the system. The software codes are as follows: 6 = magnetometer total field/VLF 7 = magnetometer base station/VLF 8 = gradiometer/VLF The last three digits is the serial number of the unit.
Press	CHANGE	ENTER	
Press		A U T O	HP NNNN will be displayed along with the DUMP or VLF DUMP descriptor, where "N" is a numeric value.
	RECORD		
Press	CHANGE + 8888 + ENTER		

The Tie-Line memory is cleared of both the magnetic and VLF data.

7b) LOOPING METHOD

This method is almost the same as the tie-line method except that, instead of selecting and recording numerous tie point references, only the base reference point is used as a bench mark. This method is applicable to smaller survey areas in which it is practical to return to the base reference point frequently to take subsequent readings. The looping survey diagram is shown below:

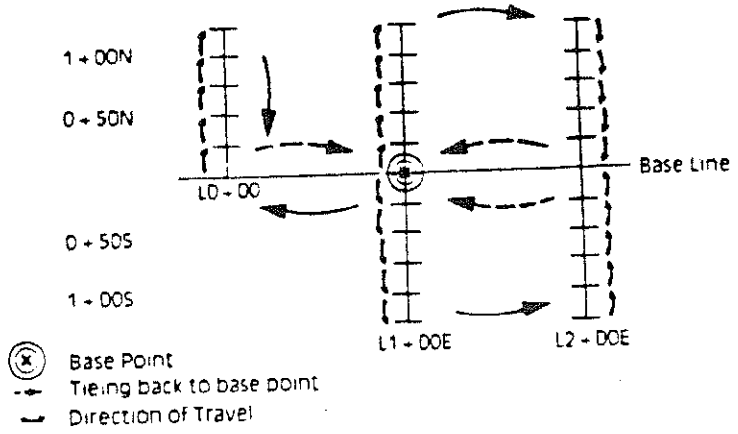

Figure 7-2
Diagram Showing the Looping Method

CAUTION

Before the looping method can be used, the tie-line memory must be initialized. Then the base reference point only will be stored. If it is not initialized, existing tie-point information will be picked up and used in computations.

SECTION 8

TROUBLESHOOTING AND MAINTENANCE

This section has been designed to help the end-user in determining problems that the operator may encounter in the field with the OMNI-PLUS System.

The OMNI-PLUS has been designed to provide reliability and ruggedness. Generally, most problems are minor and can be repaired by the end-user if he has the proper information to assist him in maintaining the system in good working order. Therefore, this chapter is devoted to providing the end-user with a guide to problems that may occur and their solutions.

In order to provide a comprehensive section, we ask our end-users to assist us in compiling information.

Problem	Cause	Solution
Erratic Magnetometer Readings	Low sensor fuel	See Appendix A-1
As above	Metallic objects on person	Check and remove all metallic objects
As above	Broken or damaged sensor cable	See Appendix A-1
As above	Instrument not in tune with the local field.	Place the unit in TEST mode and press the READ key. Next, press the FIELD/GRAD/3 key and note the field value stored. If this value is significantly different from the expected local value, then press CHANGE + local field value + ENTER. Turn the unit off and place the unit in the field mode (ie, TFM or GRAD) and press READ. The value should be close to the expected value.

Table 8-1
Troubleshooting

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Troubleshooting And Maintenance (con't)

Problem	Cause	Solution
As above	Precession board	Call EDA's service dept. (416)425-7800
"no VLF" on display prior to entering frequencies	Interconnect cable	Check interconnect cable to ensure that the VLF connector on the cable was inserted into the VLF module.
As above	As above	Check interconnect cable for damage. If the cable has been damaged, the data reduction cable may be used.
"no VLF" on the display after entering the frequencies.	Connector on the circuitry housing may be damaged.	Call EDA's service dept. (416)425-7800
Display will not change despite pushing any key	Damaged keyboard decoder chip	Call EDA's service dept. (416)425-7800
Display will not turn on	No battery power	Check battery and connectors to ensure proper power is being received to the console
As above	Power & Control problem	Call EDA's service dept. (416)425-7800

Table 8-1
Troubleshooting

Troubleshooting And Maintenance (con't)

Problem	Cause	Solution
Partial Display	Loose or improperly seated LCD	Remove the black display cover. Check the six brass screws to ensure that they are all snug. **PRIOR TO TIGHTENNING THESE SCREWS, CHECK TO ENSURE THAT THE LCD IS PROPERLY SEATED. DO NOT OVERTIGHTEN.** If all the screws are loose, tighten in a pattern.
Rechargeable batteries will not recharge	Blown fuse in the charger	Check and replace if necessary
As above	Batteries have discharged below the acceptable level	Some or all the dry cell batteries have to be replaced See Appendix A-2
Rechargeable batteries do not hold the charge for more than a couple of hours.	One or several of the cells are dead.	See Appendix A-2
"LOHLt" on the display during the dumping of magnetometer data.	The voltage on the lithium backup battery is low.	The lithium battery needs to be replaced. Call EDA's service department.

Table 8-1
Troubleshooting

SECTION 9

SUMMARY OF VLF FEATURES

This section is devoted to assisting the operator in understanding the special features of the VLF portion of the OMNI-PLUS so as maximize their benefits.

Operator Quality Number

As described in the manual, this feature was implemented into the VLF portion of the OMNI-PLUS so as to assist the operator in how well the VLF reading by taken. A value is given both graphically and numerically for every reading and frequency measured.

When the READ key is pressed, whether the unit is in TFM, AUTO, GRAD (with VLF module), VLF or VLF AUTO mode, the previous magnetometer or VLF reading is displayed. When the instrument has completed the VLF measurements, the new value of the last parameter viewed will be displayed. If this value was a VLF parameter, displayed along with this value is three sets of descriptor bars, one being the battery level indicator (BATT). The OMNI-PLUS uses the DECAY descriptor bars to indicate the operator quality.

The operator quality number goes from 0 to 9 where 0 is the worst and 9 is the best. Presently, the first digit printed under the S header is the operator quality number. For the descriptor bars, each bar (four in total) is considered approximately 2.5. To obtain the best reading, the operator must keep the VLF module vertical in both directions and stand still during the measurements. However, the best results generally obtained by an operator is 5 or 6. Therefore, the operator should try to obtain 2 or 3 bars on the descriptor.

When the VLF measurements are completed and a VLF parameter is displayed, the operator quality descriptor indicates the worst operator quality of all the frequencies measured. Therefore, if a good descriptor value is given, the operator can be assurred that the operator quality for the other frequencies is equal or better than the one displayed. If the operator wishes to determine the operator quality for each frequency measured, then if the FREQ. SELECT key is pressed, the operator quality displayed is that for the frequency indicated.

Signal/Noise Ratio Number

As described in the manual, this feature was implemented into the VLF portion of the OMNI-PLUS so as to assist the operator in determing whether the signal from the VLF transmitting station is being received at a usuable level. A value is given both graphically and numerically for every reading and frequency measured.

When the READ key is pressed, whether the unit is in TFM, GRAD, AUTO (with a VLF module), VLF or VLF AUTO mode, the previous magnetometer or VLF reading is displayed. When the instrument has completed the VLF measurements, the new value of the last parameter viewed will be displayed. If this value was a VLF parameter, displayed along with this value is three sets of descriptor bars, one being the battery level indicator (BATT). The OMNI-PLUS uses the SENSOR descriptor bars to indicate the signal/noise ratio.

The signal/noise ratio goes from 0 to 9 where 0 is the worst and 9 is the best. Presently, the second digit printed under the S header is the signal/noise ratio. For the descriptor bars, each bar (four in total) is considered approximately 2.5. The signal/noise ratio is an indicator of how well the signal is being received above the background noise level. Generally, the background noise level in most areas is a VLF total field value of 1 or less. This will be indicated on the descriptor bars as the SENSOR descriptor flashing and no bars below it. This is an indication that no usuable signal is present. Generally, the operator should see at least one bar on the descriptor indicating an usuable VLF total field value. One bar on the descriptor indicates that a signal is marginal and caution should be exercised. If one is unsure whether the data will be usuable, the operator should take several readings at one location and see if the readings are repetitive.

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Signal/Noise Ratio Number (con't)

When the VLF measurements are completed and one of the VLF parameters is displayed, the signal/noise descriptor indicates the worst signal/noise ratio of all the frequencies measured. Therefore, if a good descriptor value is given, the operator can be assurred that the operator quality for the other frequencies is equal or better than the one displayed. If the operator wishes to determine the signal/noise ratio for each frequency measured, then if the FREQ. SELECT key is pressed, the signal/noise ratio displayed is that for the frequency indicated.

NOTE

If your signal/noise ratio bars are consistant, however, you may have only 1 bar, this is still acceptable. The operator should be concerned or aware if he has been reading, for example, 3 bars and then it drops to one or no bars. This indicates a significant change in the quality of the signal and requires a closer examination of what is occurring with the signal source, cultural noises or the instrument. Therefore, it is also important to have consistant number of bars.

Generally, if the VLF total field values significantly drops along with the number of bars, it is an indication that the transmitting station is "off the air" or the output power level has decreased. If the VLF total field remains consistant with previous values, but the number of bars drop, it may be an indication of cultural noise interference (ie, power lines).

Sampling Time

The OMNI-PLUS has been designed to automatically increase the sampling time of the VLF frequencies being measured. The gain setting given during the initializing process can give you an indication on how long it will take to measure the VLF signal. For a gain setting from 1 to 7, the OMNI-PLUS takes approximately two seconds to measure the signal. For every two increases in the gain setting (ie, 7 to 9), the sampling time approximately doubles to a maximum of ten seconds. Therefore, your survey time will be dependent on what frequencies are selected and their gain settings. The next feature, Gain Setting, will indicate some guidelines regarding an acceptable gain setting.

Gain Setting

The gain setting feature, displayed during the initializing process can give the operator an indication at the start or during any part of the day, how well the signal is being received by the instrument. Although the gain setting should not be used as a sole indicator of whether the signal being received is usuable, the guidelines below are given to assist the operator in determining what further actions should be taken:

1-12	Signal being measured should be acceptable.
13-15	The signal being received is weak and caution should be exercised when using these frequencies.
16-17	Do not use.

NOTE

Please note that the gain settings are displayed as 01 to 17.

As mentioned previously, for a gain setting from 1 to 7, the OMNI-PLUS takes approximately one second to measure the signal. For every two increases in the gain setting (ie, 7 to 9), the sampling time approximately doubles to a maximum of ten seconds. Therefore, your survey time will be dependant on what frequencies are selected and their gain settings.

Principle of Operation

When using a VLF instrument that requires orientation, the normal convention is that the direction of the survey lines are selected approximately along the lines of the primary magnetic field (ie, at right angles to the direction of the station being used). Therefore, when the primary magnetic field lines encounter a conductor, the total field lines will be positive when tilted upwards, as noted in Figure 9-1. In other words, a positive tilt will be upwards in the forward direction.

When the primary magnetic field lines are at right angles to the survey lines (ie, when the survey lines are in the same direction of the station being used) and a conductor is encountered, the total field lines will be positive when tilted upwards, as shown in Figure 9-2. In other words, a positive tilt will be upwards to the right of the operator.

Since the OMNI-PLUS is designed as a no orientation system, a convention must be used so as the instrument maintains a consistancy for the sign designations. If the orientation is that as in Figure 9-1, the OMNI-PLUS initializes in what we call Mode 1. If the orientation is that as in Figure 9-2, the OMNI-PLUS initializes in what we call Mode 2. To determine whether the OMNI-PLUS is using Mode 1 or 2, the operator looks under QUAD after initializing the system. For Mode 1,0.1 is displayed while for Mode 2, 0.2 is displayed.

As one can see, the above conventions work well as long as the transmitting stations are at right angles or in line with the direction of travel. However, in some cases it is difficult to use a transmitting station at right angles or in line with the line direction.

Figures 9-3 and 9-4 demonstrate the situation that arises when a transmitting station is not a right angles or in line with the line direction (primary field lines). The OMNI-PLUS selects between Modes 1 and 2 depending on the orientation of the primary field lines. If the primary field lines are +ve or -ve 0 to 45 degrees of the line direction, the OMNI-PLUS will use Mode 1 as the reference for the duration of that day's survey as long as the instrument is not re-initialized. If the primary field lines are +ve or -ve 45 to 90 degrees of the line direction, the OMNI-PLUS will use Mode 2 as the reference.

Principle of Operation (con't)

Since the selection of Modes 1 or 2 occurs during the initialization process, it is important that the operator face the direction of travel during this process. Once the initialization process is complete, the operator performs the survey as suggested in this manual. It should be noted that once the initialization process is complete and Mode 1 or 2 is selected, changes in the direction the operator will not change the Mode selection.

This process was implemented so as to maintain proper sign designation as per the normal convention. The one thing the operator should be aware of is that he maintains the same Mode throughout the completion of the survey. If Mode 1 was the mode that the OMNI-PLUS used during the initialization process, the operator should make sure that Mode 1 is used on subsequent days of that particular survey.

NOTE

If the operator changes his survey direction more than 60 degrees (ie. a regular line to a baseline) it is very important that the operator RE-INITIALIZES the system. This does not erase any previous measured data.

Degree Measurement

Under the VLF program, the OMNI-PLUS measures and calculates the direction of the primary field in regards to the operator. This information is stored and outputted for each reading taken. This information in helping the operator assess whether the signal being measured is valid and to determine whether a conductive body changes the direction of the primary field lines.

The direction the operator is facing is considered zero degrees. The value, in degrees, is given from $\pm$ 0-90 degrees. To the right of the operator is considered positive, while to the left of the operator is considered negative. A signal coming in at right angles to the direction the operator is facing would be considered 90 degrees. In other words, the primary field lines are parallel to the direction the operator is facing. A signal coming in front or behind the operator would be considered $\pm$ 89 degrees. In other words, the primary

field lines are perpendicular to the direction the operator is facing. Please note that although the values are given from 0-90 degrees, the system can only tell you at what angle the primary field lines are cutting the sensor, but not whether the signal is for example coming in from the right or the left of the operator.

Corrected VLF Total Field Results

The VLF total field data can be corrected for primary field variations. This can be achieved using either the tie-line method or more accurately, a base station unit. However, since the OMNI-PLUS requires no orientation for the VLF, one magnetometer total field and up to three VLF frequencies can be measured with one system. The VLF total field is corrected as a ratio, thereby, the corrected results are normalized. This feature is standard in all OMNI-PLUS Base Station or Gradiometer Systems.

As opposed to in-phase or quadrature, the total field results are susceptible to variations caused by atmospheric effects or abrupt changes in the power output from the transmitter. Although conductivity contracts may be apparent in the total field data, presentation of the data may be difficult due to changes in the amplitude of the primary field.

Therefore, when using a VLF base station, readings can be taken at a selectable time interval from 5 seconds to 60 minutes. During the dumping process, the "base unit" total field results are adjusted to correspond to the exact time the "field unit" total field results were taken using linear interpolation. Then the "field unit" total field values are corrected by dividing the field values by the corresponding (time) base value and multiplying by 100. This process normalizes the total field results.

Readings Adjusted for Sign Convention

In standard VLF survey methods, a single or consistant direction is used to maintain comparable signs on all in-phase, quadrature or tilt values relative to each other. Since the OMNI-PLUS is a no orientation system, a convention was selected that maintained the standard convention that North and East are positive and South and West are negative.

Therefore, the profiles plotted looking east (i.e. S to N) and north (i.e. W to E) will have the crossover in the correct sense (positive to negative).

In the OMNI-PLUS, the data can only be stored as a positive or negative value. Therefore, the following has to be observed:

1) South or west lines or stations - enter negative.
2) North or east lines or stations - enter positive.
3) Walking south or west (ie, position spacing) - enter negative.
4) Walking north or east (ie, position spacing) - enter positive (no sign).

The OMNI-PLUS uses the sign of the position spacing to automatically adjust the sign of the VLF in-phase, quadrature and tilt data. If the position spacing is positive walking north or east) the data is displayed and stored as it is measured. However, if the position spacing is negative (ie walking south or west) the sign is inverted from that measured prior to being displayed and stored.

NOTE

It is important that the operator face the direction he is walking regardless the orientation to the VLF transmitter.

If this convention is opposite to that used for your applications, there is a provision in the dumping sequence to invert the sign of the VLF in-phase, quadrature and tilt data (See Section 6).

Error Messages

To assist the operator in determining whether there are any external or internal problems affecting the performance of the system, error codes have been implemented to assist the operator in determining if a problem exists in the VLF portion of the system.

There will be a set of nine error codes that will be displayed, with the following seven implemented:

1) **Strong Interference.** This is to warn the operator that the VLF signal has been impeded by a strong noise source (ie thunderstorm activity).

2) **Bad Power Supply.** This is to warn the operator that the VLF module is experiencing a partial or total disruption of power. It should be noted that the VLF module has its' own power supply which draws its' current from the battery cartridge attached to the console.

3) **Ram Error.** This is to warn the operator that there is a problem with the operating system of the VLF module. The VLF module includes a CPU system, which in turn, is controlled by a set of eproms. These eproms are independent of the eproms located in the OMNI-PLUS console.

4) **Tilt Transducer Error.** This is to warn the operator that there is a malfunction related to the tilt transducer. The tilt transducer is located in the VLF module and is used to compensate the in-phase, and tilt values due the misalignment of the coils by the operator.

5) **VLF Calibration Error.** This is to warn the operator that one of calibration values is outside of the acceptable range.

6) **Resistivity Calibration Error.** This is to warn the operator that one of the calibration values is outside of the acceptable range.

7) **Weak Signal.** This is to warn the operator that the signal strength of one of the VLF frequencies selected is below an usuable level.

These errors are displayed and stored under the in-phase parameter. For example, the error "Strong Interference" would be displayed as UEI (VEI) and stored as 991. In future, the error codes will be stored under column 45 of the VLF ASCII dump.

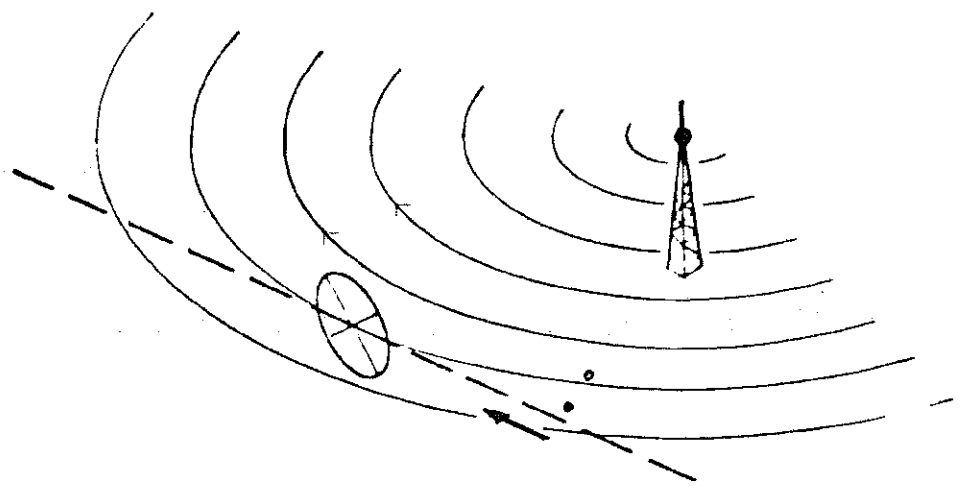

Figure 9-1
Mode 1

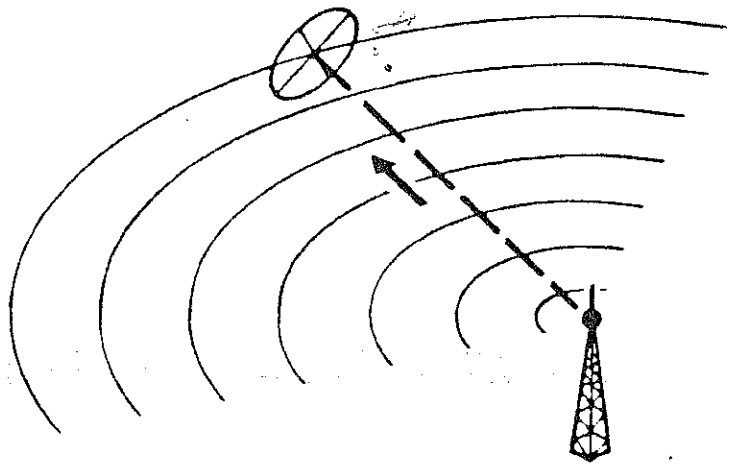

Figure 9-2
Mode 2

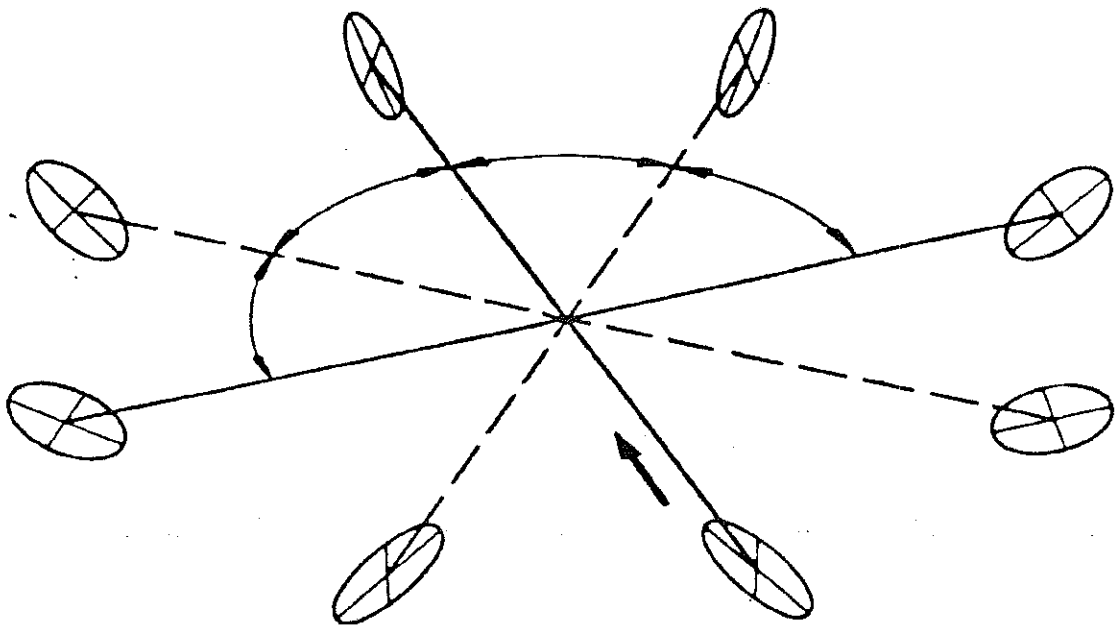

Figure 9-3
Selection of Modes

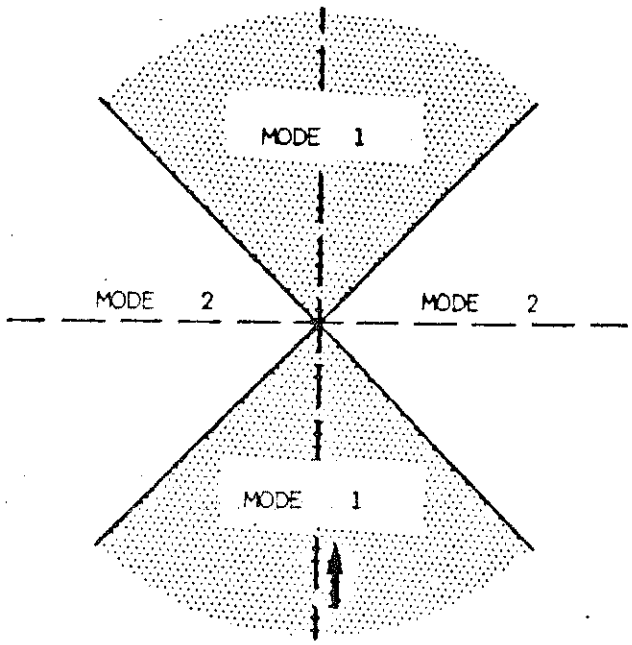

Figure 9-4
Mode Fields

VLF Spectrum

The VLF spectrum was designed to allow the user to determine whether there may be usuable VLF frequencies within the 15.0 to 30.0 KHz range.

The following pages describe the procedure for obtaining spectrum results. These results can then be examined (Figure 9-5) and usuable signals determined. Results from Bathurst, New Brunswick, Canada (Figure 9-5) were plotted using a log-linear scale. As discussed earlier, any frequency with a total field value of 1 or greater can be used.

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INSTRUCTIONS FOR TESTING VLF SIGNAL STRENGTH

These instructions are given to assist the operator in determining the capability of the OMNI-PLUS VLF.

PART A

1. Assemble the OMNI-PLUS without the magnetometer component.
2. Face a known direction that can be tied into a map.
3. Enter in the operator code OP3000 and a frequency of 14.0 for Fre 1 and 00.0 for Fre 2 and 3.
4. Initialize the system (you will find this init process will take only a couple of seconds).
5. Store the initialization value under SPOT RECORD.
6. Select VLF mode and press READ. The first reading will be under frequency 15.0 kHz. The total field on the display will be used as a preliminary indication of a viable signal. Generally, a value of .50 or less is the noise produced by the system. You should be looking for values above 1.00. A good indication of a viable signal is that you will see a symmetrical peak as values gradually increase and decrease from the highest signal. Note any frequency that are above 1.00.

1.44

7. Store this value under SPOT RECORD.
8. Press READ. The instrument will automatically increment the frequency (ie, the next one will be 15.1 kHz). Once again, note for any symetrical increases. If you want to check what frequency you are at, press FREQ. SELECT.
9. Repeat steps 7 and 8 until you have reached 30.0 kHz.

NOTE

Even if you do not get a proper reading after pressing READ, store the results. The instruemnt will increment the frequency regardless whether it is stored or not.

PART B

This part of the test involves specifically determining whether the signals measured could be viable stations.

1. For all these tests, you must use a strong, known transmitting station that you know it's direction (ie, Cutler in Canada, Bordeaux in Europe, Exmouth in Australia). This will be your Freq 3 in all tests.

2. Select two of the frequencies you wish to test and enter them as Freq 1 and 2. Initialize the system. This process may take 30 to 45 seconds. If the unit beeps, press any key. When your initialization values are completed, examine them carefully as follows:

   Phase 67.7-73.7
   Quad 0.0 or 0.2
   Field 2000-4000
   Tilt 01 to 17

   If any of the first three numbers are not within the specified range proceed and contact us when possible. As for the signal strength, if the number is 16 or 17, select another frequency.

3. Select VLF mode and facing the known direction, take three readings, storing each reading under SPOT RECORD.

4. Now turn approximately 90 degrees and take three more readings. The reason for using the strong signal under Freq 3 is to compare the degree changes. Since it is hard to turn exactly 90 degrees, you compare the change in degrees of the strong station to the weak (ie, the amount of change should be the same).

5. Repeat steps 2 to 4 until all the frequencies are completed. Regardless of their strength, try all known frequencies unless the gain setting is 16 or 17.

6. The last test is to measure three frequencies that are noise to determine the exact background noise of the system. The spectrum is not the most accurate way of determining this. Enter in frequencies 15.5, 20.5 and 29.5 kHz and initialize. Store these init values under SPOT RECORD.

7. Take one reading in the VLF mode and store under SPOT RECORD.

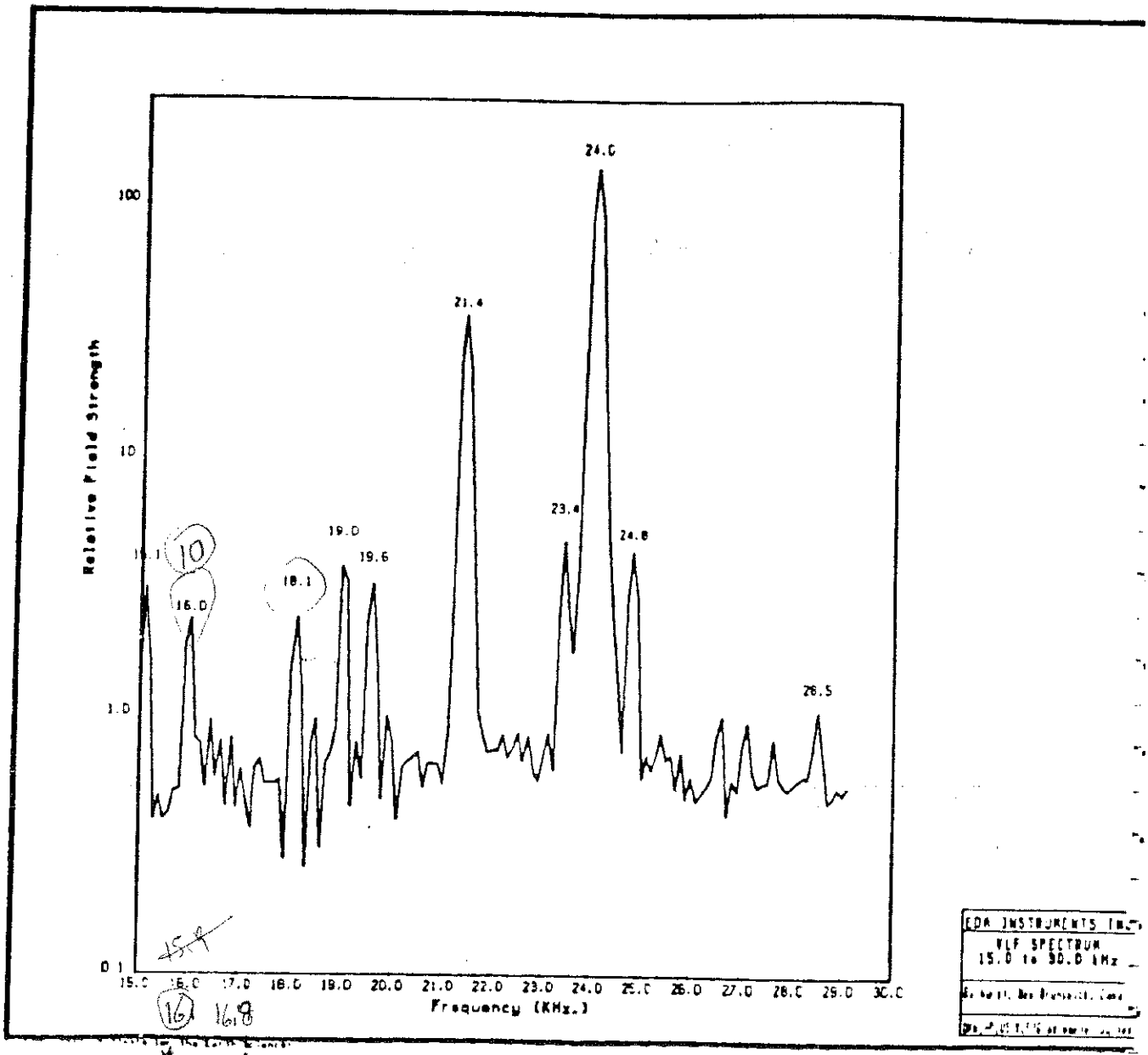

Figure 9-5
VLF Spectrum
15.0 to 30.0 KHz
Bathurst, New Brunswick, Canada

SECTION 10

OPERATION OF THE VLF RESISTIVITY OPTION

10.1 INTRODUCTION

The following is a brief description of the operation of the OMNI-PLUS VLF resistivity option (Revision 1.1).

The OMNI-PLUS system with resistivity option functions the same as for the standard OMNI-PLUS combined magnetometer/VLF system as described in this manual. The main difference is that when resistivity probes are plugged into the VLF electronics module, then the OMNI-PLUS will automatically measure and calculate an apparent resistivity and phase angle for the VLF frequencies measured.

The resistivity option is offered in two configurations; two probe resistive/capacitive or three probe resistive/capacitive. The difference in these configurations is with the two probe, the probes must be oriented to the direction of the transmitter. However, no orientation to the transmitter is required with the three probe system.

10.2 OPERATING PROCEDURES

(1) Initializing the Unit

Ensure that the OMNI-PLUS system has been connected as described in Section 5 of this manual. Attach the resistivity probes to the VLF electronics module that is worn on the operators back. The 10 pin KPT connector is located on the left side of the module with the word "RESISTIVITY" noted below the connector.

For the three probe system, the single electrode is attached to the 6 pin KPT connector located above the 10 pin KPT connector. If the operator has the three probe system, he can use the system in a two probe configuration by not connecting the third, single electrode.

The two probe system requires that the operator align himself so that he is facing perpendicular to the direction of the probes. The operator must also ensure that the probes are within +/- 30 degrees to the electric field direction. This can be done by making a trial reading and noting the direction of the magnetic primary field lines given as the first parameter under the RESIST key (the electric field is perpendicular to this direction). After a few readings the operator should be able to determine the correct orientation for the probes for subsequent readings.

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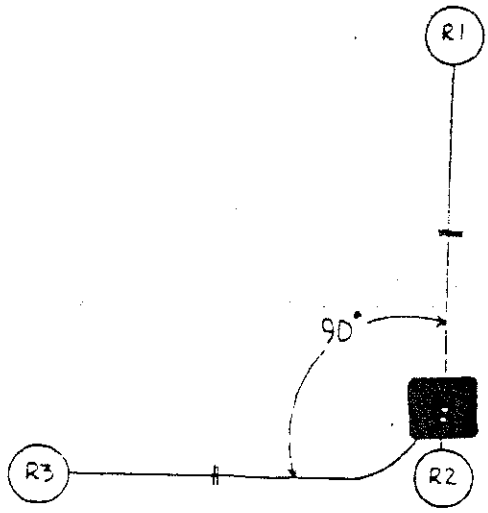
(1) Initializing the Unit (con't)

Once this orientation is determined, place the electrode with the longer cable into the ground outwards from the station along this orientation, to the full length of the cable. Place the electrode with the shorter cable in the ground at the survey station. Be sure to fully insert the electrodes into the ground when using resistive probes. If capacitive probes are to be used, ensure good contact with the measuring surface.

Although it does not matter what side of the line that you place the far electrode on, you should maintain this same orientation for the particular survey line.

Although, for the three probe system no orientation to the transmitter is required, the operator must align the single electrode perpendicular to the electrode located next to the operator, and at the same spacing as the dual electrodes (see below).



Because of the orientation requirement for the two probe system, it is best to only read one frequency at a time for optimum results. However some compromise can be made if two or three stations are coming in from the same basic direction (i.e. +/- 30 degrees of one another). In this case it is possible to read more than one frequency at a time.

For the three probe system, up to three frequencies may be read at one time without concern regarding primary field direction.

At the beginning of the day the system must be initialized as per the instructions in Section 5-4-2. One very important difference is that if resistivity measurements are to be taken, then the resistivity probes (two or three probe system) must be attached to the OMNI-PLUS system prior to the initialization process. Also, the resistivity probes must be placed in the ground and orientated as described above.

During the initialization process the OMNI-PLUS will initialize the magnetic parameters as well as the electric (resistivity) parameters if the probes are connected. A description of the parameters returned for the VLF magnetic initialization can be found on page 5-23.

Test parameters are also returned for the VLF electric (resistivity) initialization. The parameters returned are a result of a calibration/self test that the OMNI-PLUS performs and these values should be checked prior to the start of the survey to confirm that the system is functioning properly.

The parameters displayed for the resistivity initialization are accessed by pressing the RESIST key. By repeatedly pressing this key you can toggle through the parameters. These values should be as follows:

Primary Field Direction	0
Resistivity	50 to 200
Phase Angle	-10 to 100

NOTE

The initialization values obtained are valid for both the two probe and three probe systems.

If the value displayed are outside of this range, then there may be a malfunction in the system. Ensure that the system has been set up correctly and try the initialization again, if the values still do not appear to be correct then contact an EDA representative for assistance.

(2) Taking a reading

Once the initialization process has been completed and all values are determined to be correct you can begin normal survey operations.

Put the OMNI-PLUS in the TFM, GRAD or VLF position and once the probes are inserted (resistive) into the ground or placed firmly on the ground (capacitive) and oriented properly press READ. Once the OMNI-PLUS has completed the reading process, the parameter last viewed will be displayed. The Resistivity values can be viewed by pressing the RESIST key, by repeatedly pressing this key you can toggle through all of the VLF electric parameters.

The parameters displayed are:

1. Direction - Displayed in Degrees
   - Direction of the magnetic primary field lines from the transmitter station relative to the operator.
2. Resistivity - Displayed in Ohm-meters
3. Phase Angle - Displayed in Degrees

10.3 Data Retrieval

The VLF resistivity data is transferred to a computer or peripheral along with the standard VLF magnetic data. The data retrieval procedure is described in Section 6 of this manual.